Electrical Engineering

June
1932

leveland, Ohio | 48th Annual Summer Convention | June 20-24, 1932

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American Institute of Electrical Engineers

FUTURE MEETINGS of the AMERICAN INSTITUTE of ELECTRICAL ENGINEERS

Place	Date	Nature	Manuscript Closing Date
Cleveland, Ohio	June 20-24, 1932	Summer Convention	(Closed)
Vancouver, B. C.	Aug. 30-Sept. 2, 1932	Pacific Coast Convention	(Closed)
Baltimore, Md.	October 10-13, 1932	District Meeting	July 10, 1932
New York, N. Y.	Jan. 23-27, 1933	Winter Convention	Oct. 23, 1932

NOTE: Members who are contemplating submitting papers for presentation at any of the above meetings should communicate promptly with Institute headquarters, 33 West 39th Street, New York, N. Y., so that such papers may be docketed for consideration by the technical program committee, which formulates programs for all meetings several months in advance. Upon receipt of this notification, Institute headquarters will mail to each prospective author important and helpful information explaining the Institute's rules relating to the preparation of manuscript and illustrations.

Future Meetings of Other Technical Organizations

Society and Nature of Meeting	Place	Date	Correspondent
American Assn. for the Advancement of Science	Syracuse, N. Y.	June 20–25	A. L. Elder, Syracuse Univ., Syracuse, N. Y.
American Physical Society, joint meeting with Am. Assn. for the Advancement of Science, Pac. Div., and Astronomical Society	Pullman, Wash.	June 17–18	L. B. Loeb, Pacific Coast Secy., Univ. of California, Berkeley, Calif.
American Physical Society	New Haven, Conn.	June 23–25	W. L. Severinghaus, Secy., Columbia Univ., New York, N. Y.
American Physical Society	Chicago, Ill.	Nov. 25–26	W. L. Severinghaus, Secy., Columbia Univ., New York, N. Y.
American Society of Civil Engineers	Yellowstone National Park	July 6–9	G. T. Seabury, Secy., 29 West 39th St., New York, N. Y.
American Society of Civil Engineers, fall meeting	Atlantic City, N. J.	Oct. 5–8	G. T. Seabury, Secy., 29 West 39th St., New York, N. Y.
American Soc. of Mech. Engrs. semi-annual convention	Lake of Bays, Ontario, Can.	June 21–July 1	C. W. Rice, 29 W. 39th St., New York, N. Y.
American Society for Testing Materials	Atlantic City	June 20–24	Am. Soc. for Test. Mtls., Phila., Pa.
Canadian Electrical Association	Murray Bay, Quebec, Can.	June 15–17	B. C. Fairchild, 409 Power Bldg., Montreal, Can.
Illuminating Engineering Society	Swampscott, Mass.	Sept. 26–Oct. 1	E. H. Hobbie, 29 W. 39th St., New York, N. Y.
International Electrical Congress	Paris, France	July 5–12	Harold Pender, Univ. of Pa., Phila., Pa.
N.E.L.A. New England Division	Bretton Woods, N. H.	July 11–13	Miss O. A. Bursiel, 20 Providence St., Boston, Mass.
N.E.L.A. Pacific Coast Electrical Assn.	Pasadena, Calif.	June 14–17	K. I. Dazey, 447 Sutter St., San Francisco, Calif.
N.E.L.A. Rocky Mountain Div., annual meeting	Estes Park, Colo.	Sept. 12–14	G. E. Lewis, Managing Dir., 366 Gas and Elec. Bldg., Denver, Colo.
South American Electrotechnical Congress	Buenos Aires, Argentina	July 4–11	R. F. Ascher, Secy., Paseo Colon 185, Buenos Aires, S. A.

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This Month—

Front Cover

Downtown Cleveland from the air. Summer convention headquarters will be at the Hotel Cleveland, the nearest building of the Terminal Group which appears in the lower right hand corner of the view.

Photo by Hunter Aerial Surveys Co., Cleveland, Ohio

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NATIONAL and District prizes awarded by the A.I.E.E. for technical papers presented during 1931 were announced recently. *p. 418*

THE telephone handset, although "taken for granted" as are many of our modern conveniences, required long and painstaking research to make it a practical reality. *p. 380–383*

H. H. HENLINE, for more than five years assistant national secretary of the A.I.E.E., on June 1 became the Institute's managing executive by unanimous action of the board of directors. *p. 415–416*

POST-WAR deflation combined with a slackening of opportunity for profitable investment are held responsible for present economic conditions. This is one of the theories advanced in a progress report of a comprehensive study undertaken by a special committee of the American Engineering Council. *p. 373–379*

ALL ABOARD for Cleveland and the Institute's annual summer convention to be held in the "forest city" June 20–24! There will be no registration fee; special entertainment and sports events are scheduled; interesting inspection trips are planned; all technical sessions are to be held in the mornings. *p. 414.* Abstracts of papers to be presented are published in this issue. *p. 405–413*

WHEN planning your summer vacation don't overlook an excellent opportunity to combine business with pleasure by attending the 1932 A.I.E.E. Pacific Coast convention to be held August 30 to September 2 in Vancouver, B.C. Popularly known as the "evergreen playground" this young and progressive city and the surrounding country possess unusual recreational attractions. *p. 414*

A POWER STATION in which the development over a ten-year period had been such that the latest unit has practically five times the capacity of the first, offers a distinct challenge to the engineer; such is the history of the Waukegan generating station of the Public Service Company of Northern Illinois. Its latest installation includes a 115,000-kw. single-shaft steam-electric generator, and the first 132-kv. metal-clad switchgear ever built. *p. 391–400*

Keep Abreast of Your Profession

By E. B. MEYER, FELLOW A.I.E.E. — Chairman A.I.E.E. Publication Committee
G. ROSS HENNINGER, MEMBER A.I.E.E. — Associate Editor, A.I.E.E.

Can you attend six conventions a year? Can you digest 150 or more technical papers each twelve months? Can you personally meet satisfactorily the demands imposed by the continuing rapid evolution in the art of electrical engineering and its successful application? This article may reveal to you unexpectedly available facilities.

IN A SENSE this is an anniversary month, a seemingly reasonable excuse for a bit of stocktaking. Just two years ago, May 5, 1930, to be exact, the A.I.E.E. publication committee concluded more than two years of intensive investigation, and brought forth its memorable report on "proposed changes in policy of A.I.E.E. publications." Subsequent adoption by the board of directors, June 23, 1930, converted the committee's recommendations into Institute policy, one of the tangible results of which was ELECTRICAL ENGINEERING as a New Year's greeting for 1931.

BASIC PLAN

To provide a basis of comparison, a few of the more important points involved in the publication committee's 1930 recommendations will be outlined briefly here.

Recognizing that the Institute to keep growing must be alive to the changing requirements of its members; recognizing that the Institute's activities and publications to serve adequately must be alive to changing conditions; and recognizing that the monthly publication constitutes the main channel through which Institute members may keep informed conveniently and effectively as to current technical and professional developments and the Institute's participation therein, the committee selected the monthly publication as representing the logical field in which to pioneer the development of increased and more effective publication service to members. Out of the hundreds of letters exchanged in the publication committee's nationwide survey, the general features of a basic policy took the following tangible form:

1. Organize the editorial content of the monthly publication to serve better the needs and desires of the average individual member of the Institute.
2. Include, at least in the form of comprehensive interpretative abstracts, every paper formally presented before Institute conventions and District meetings.
3. Give special attention to the more timely papers of wider general interest.
4. Distribute to the entire membership the annual reports of the Institute's technical committees.
5. Solicit and convey to the membership special articles on timely scientific, economic, and other subjects of interest and importance to electrical engineers.
6. Reflect important contemporary developments in allied fields, and
7. Reflect more adequately the Institute's important activities, including its Section and Branch work.

In short, the assignment called for the Institute's monthly publication to carry conveniently and directly to every Fellow, Member, Associate, and Enrolled Student of the Institute a comprehensive and illuminating month-by-month cross-section of professional activities and electrotechnical developments in many related fields of endeavor.

WHAT HAS BEEN DONE?

Comments from members indicate that for sixteen months ELECTRICAL ENGINEERING has been doing this job with increasing effectiveness. From January 1931 to and including May 1932, ELECTRICAL ENGINEERING has brought you comprehensive interpretive abstracts of 128 Institute papers, 179 articles giving you either the entire or the essential substance of an equal number of Institute papers, and 84 articles of a special character selected for their timeliness and importance and to give a better balance to the published material. ELECTRICAL ENGINEERING in these few months has reported the activities at four national conventions and six District meetings, to say nothing of almost innumerable other events of significance and importance. For those who might enjoy some interesting statistical information, the accompanying tabulation is presented.

A REAL JOB

ELECTRICAL ENGINEERING's relentlessly prosecuted endeavor is to serve to the greatest possible advantage the maximum proportion of the Institute's entire membership. The magnitude and complexity of this endeavor perhaps may be made more understandable by an analysis revealing the tremendously wide spread of activities in which Institute members are engaged. On the basis of the Institute's enrolment as recorded in the 1930 Year Book—17,633 Members and 2,446 Enrolled Students totaling 20,079—approximately 16 per cent are in design and manufacturing, 9 per cent in communication, 6 per cent in industry, 5 per cent in construction, 18 per cent in electric power supply, 3 per cent in railways, 6 per cent in research and education, 1 per cent in radio, 12 per cent are students, 16 per cent unclassified, and 8 per cent are in foreign fields.

For any one publication to attempt to serve exhaustively all the interests of such a widely diversified group obviously would result in a ponder-

ous volume; for a publication to devote itself exhaustively to the interests of any one group would be to disregard the interests of the others. One of the prime functions of the Institute is to serve as a coordinating medium embracing these closely related groups of diverse interest. It is the function of ELECTRICAL ENGINEERING to effect an interchange of information by means of which individual members may reduce the inevitable personal hazard of ever-narrowing specialization in professional practise.

A STRONG POLICY

ELECTRICAL ENGINEERING is based upon a liberal, constructive policy, and is designed with sufficient flexibility to meet effectively the constantly changing requirements of the Institute's membership. Into its policy are inculcated a bit of reticence and reserve to preserve its stability, sufficient initiative and daring to prevent its stagnation, a reverence for tradition in so far as that tradition is soundly founded and still serving a definitely useful purpose, and above all, a driving motivation to serve honestly, effectually, and unselfishly; it is edited for Institute members by a staff of Institute members whose prior industrial service has provided a solid background of experience.

INTERPRETIVE ABSTRACTS

One experiment has concerned the manner and form of publishing abstracts of formal Institute papers. From the earlier policy of publishing miscellaneous groups of abstracts month by month, the plan has evolved to the present practise of publishing, directly in conjunction with the meeting at which they are presented, a related group of carefully prepared interpretive abstracts. This present plan accomplishes a wide and time distribution of essential facts covered in current papers, and clears the way for a full and independent treatment of those subjects of greatest timely importance and widest general interest.

Another experiment, also initiated through the 1930 report of the publication committee, seems definitely to have come to a close. In fourteen successive issues some 1,458 "selected items" from the Engineering Index's current periodical reference service were republished. Since the complete reference service is rather widely available through the libraries of the country and through direct subscription, and since, at best, only limited space was available in ELECTRICAL ENGINEERING, this publication experiment was concluded in the February 1932 issue.

Contents of ELECTRICAL ENGINEERING for the 12 Issues of 1931

	Classification of Material	No. Pages
1.	137 technical articles giving the essential substance of 150 A.I.E.E. papers (also 29 interpretive abstracts of Pacific Coast and Kansas City papers)	360
2.	Annual reports of 17 Institute technical committees	90
3.	33 special articles including non-technical contributions	85
4.	27 special articles originating in or coming through Institute channels	69
5.	News reports covering three national conventions, three District meetings, and other Institute activities	85
6.	Brief reports of 492 Section and 1,112 Branch meetings	57
7.	1,231 selected references to current periodical electrical literature	48
8.	311 personal items pertaining to activities of Institute members	33
9.	798 items from Engineering Societies Employment Service	27
10.	Reference listings of A.I.E.E. official and committee personnel (published in full in January and September, in part in February and March)	21
11.	News of activities of other engineering societies	18
12.	Postings of 1,073 members for election or transfer	14
13.	Notices of 165 new books of interest to electrical engineers, as received by the Engineering Societies Library	11
14.	13 "Letters to the Editor" (a new column started late in the year)	6
15.	Miscellaneous material	74
	Total pages editorial content	998

MORE FOR YOUR MONEY

To improve its production and distribution, ELECTRICAL ENGINEERING recently completed an extensive and critically searching inquiry into these phases of its operations. As a result, it has transferred its production activities to a new and larger plant removed from New York's congested metropolitan area and devoted primarily to scientific and technical periodicals. Benefiting from its new and improved facilities, ELECTRICAL ENGINEERING now brings to you in its usual 72 pages of editorial content an amount of material that previously would have required 79 pages, and should reach you several days earlier than heretofore. New paper of higher quality and softer finish now protects your eyes from the fatigue of reflected light; greater opacity improves readability. Of importance and significance in connection with these improvements is the fact that, at the same time, production costs have been reduced materially.

OPEN FORUM

In its present experimental "Letters to the Editor" columns, ELECTRICAL ENGINEERING offers to the members of the Institute a readily available channel for the frank and informal discussion of almost any topic of timely interest. These columns are gaining in apparent popularity; certainly they merit attention and widespread use.

YOUR JOURNAL!

The monthly publication ELECTRICAL ENGINEERING is well understood to be one of the Institute's most important services to its every member; therefore its publication committee and staff are determined to pursue relentlessly every opportunity to make this service more widely useful and more definitely valuable. It will continue to pioneer the way in the direction of greater and more effective publication service to Institute members; it will continue to prosecute experiments into unknown portions of the field represented by membership desires; it will make mistakes, undoubtedly, but it will not falter in its *effort* to serve. Its ambition is to be neither the first to absorb every new idea, nor the last to abandon an old one that has become out-moded.

ELECTRICAL ENGINEERING is your publication, produced aggressively to the composite specifications of the Institute's membership. Use it! Contribute your ideas for its improvement that it may continue to serve you, and better.

The Relation of

Consumption, Production, Distribution

A Progress Report of American Engineering Council*

AMERICAN Engineering Council in January 1931 authorized the appointment of a special committee to study the relation between consumption, production, and distribution. When appointed, the committee was assigned the task of studying the following suggested points of attack relating to the balancing of economic forces:

1. Maintaining or increasing the consumption of goods and services
2. Balancing of plant, machinery, and processes against production demands
3. Balancing of distribution agencies against consumer requirements
4. Balancing of man power against production and distribution demands
5. Controlling of money and credit to satisfy the needs of government, business, and individuals
6. Encouragement of research activity to increase human well-being through development and progress in industry and business
7. Balancing of public works against public needs.

Council has undertaken a comprehensive study of a far-reaching problem which in one way or another undoubtedly affects every member of the Institute. In recognition of the highly controversial nature of this whole general subject, essentially the full text of a progress report is presented in ELECTRICAL ENGINEERING, without comment, but with an open invitation for comments, criticisms, and suggestions. ——The Editors.

To this list has been added one other, which is involved in all of the others, and is of such importance as to demand particular study:

8. Balancing of agricultural supply with effective demands.

Economic balance obviously can be attained at widely different levels of the general standard of living. However:

The committee has interpreted its commission as being the selection and recommendation of such governmental, financial and business policies as will maintain in the United States a standard of living that is high, broadly distributed and free from severe fluctuations.

Being acquainted with the control of the forces and the utilization of the materials of nature for the benefit of man through the instrumentality of modern technology, and realizing that this method is applicable likewise to the control of many economic forces:

The committee believes that the objective stated is physically possible for the whole of western civilization.

This statement is contrary to the assumption revealed in much present day speaking, writing, and thinking on economic matters.

Furthermore, in view of the natural resources, the technological development, the limited degree of dependence upon foreign countries for raw materials, and other important factors which characterize the United States:

The committee believes that in a very large degree the desired economic readjustment can be realized in the United States, even though it may be impracticable to accomplish such a purpose throughout the western world.

This thought is contrary to a large body of opinion which questions the ability of the United States to rise above world conditions.

In studying the problems outlined, the committee has not confined itself to engineering viewpoints, nor to engineering solutions. Observed similarities between engineering and economic principles are accepted as evidence of a vital relationship between the two sciences.

Present Situation Inadequately Explained

In an effort to establish a working hypothesis, the committee endeavored to find adequate explanations for the present economic situation. As a result the committee finds the following popular explanations to be questionable and/or inadequate:

Technological unemployment
Wasteful manufacture and distribution
General over-production
Speculation
Installment buying
Breakdown of international trade and credit

Technological unemployment is the term commonly applied to the displacing of labor by the improvement of machinery, processes, and organization. Some have assumed that a catastrophic cumulation of unbalance from this cause s responsible for the present recession in business, but no evidence is available to prove this, and there is definite evidence to the contrary. This statement is not intended to minimize the seriousness of the problems which do arise from technological advance. At times the effect of progress *does* fall with crushing force upon individuals, business firms, entire industries, and whole communities. However, it must be remembered that technological developments

* A progress report of American Engineering Council's committee on the relation of consumption, production, and distribution: R. E. Flanders, *chairman*, mgr. Jones & Lamson Mch. Co., Springfield, Vt.; L. P. Alford, vice-pres. Ronald Press Co., New York, N. Y.; F. J. Chesterman, vice-pres. & genl. mgr. The Bell Tel. Co. of Pa., Pittsburgh, Pa.; Dexter S. Kimball, dean, col. of engg., Cornell University, Ithaca, N. Y.; L. W. Wallace, exec. secy. A.B.C., Washington, D. C.

"There are millions of families whose power to consume is lowered by faulty economic conditions. In the opening of the dormant markets they represent lies the greatest hope of American industry."

have been going on for centuries; also that the normal method of adjusting the volume of production to a general increase in production efficiency has been a progressive shortening of working hours.

Wasteful manufacture and distribution, while of serious proportions, cannot be assigned as the primary cause of the existing unbalanced economic condition, and there is no element in its elimination that could be used for direct control of the business cycle. Doubtlessly distribution inefficiency has mitigated the severity of the problem of technological unemployment. Elimination of waste in both manufacture and distribution should be aggressively pursued because of its direct influence upon raising the standard of living and increasing leisure.

General overproduction is a commonly assigned primary cause for the business depression. In this point of view the committee cannot concur, although there may have been overproduction in specific industries. Individual readjustments required often are violent and even destructive, but their necessity never has been absent in good or in bad times. There is no evidence that their effects have been cumulative at this time. In view of the large increase in consumption physically possible in this country, the probability of having approached a condition of *general* overproduction is indeed remote. The real difficulty is due to the lack of a proper balance between production, purchasing power, and consumption; not to overproduction.

"The depression which began in 1929 seems to be the recession phase of a typical business cycle occurring coincidently with a typical post-war deflation, and aggravated by a unique agricultural distress and a slackening of the opportunities for investment at a profit. This is a sound statement of the cause of the present depression because it comprehends a large area of observed phenomena."

The inordinate speculation which preceded the collapse of the boom in 1929 undoubtedly was an aggravating element in the economic situation. This phenomenon and its opposite, the unreasoning panic which followed, are important psychological factors, but that they are primary causes of the business depression is doubtful. The time honored assumption that the open market is a steadying influence on prices evidently is a myth, at least in so far as the security market is concerned during periods of expansion. If the open market is to justify its existence upon the grounds that it has a steadying influence on prices, it must accomplish internal reform to bring its performance in line with this assumed purpose. Investment bankers and the speculating public both have definite responsibilities in the matter.

Installment buying. The wide extension of consumer credit masked the failure of purchasing power to keep in step with production, a primary factor in the boom which ended in 1929. In the situation thus created, the normal effect of slackening demand was delayed and the unstable balance prolonged. Recovery has been hindered by the necessity for applying new earnings to the payment of goods already in use, instead of using them to move goods of current manufacture. There are, nevertheless, unrealized possibilities of usefulness in the extension of consumer credit, provided it is done in an appropriate degree at the proper time of the business cycle.

Breakdown of international trade and credit. No doubt the demoralized economic condition in Europe resulting from the World War has had a pronounced influence upon the economic condition of the United States. This is a serious situation. There is a growing belief that the financial and industrial operations of this country have been tied to foreign operations too closely and in too complicated a manner. Also it is believed that this situation has not been of any lasting benefit to either this or other countries. However, the breakdown need not be an insuperable barrier to recovery in this country in view of our wealth, natural resources, technical ability, and the small degree of necessary dependence on foreign commerce.

Apparent Causes of Present Depression

The typical business cycle is characterized by a failure of purchasing power to keep in balance with production. A classical economic theory asserts that purchasing power normally keeps in balance with production, being in its nature complementary thereto and consequent upon it. The theory holds under an ideal condition where business enterprise is neither expanding nor contracting, but is regularly paying out all it receives—provided all individuals, governments, and the like, do the same thing.

That this is not the normal course of business, because both individuals and business enterprises find necessary the saving of funds for future use, is the contention of two well-known authorities, Foster and Catchings, in their books "Money" and "Profits," and their numerous magazine articles. For a time at least, this act of saving withdraws funds from purchasing power, and thus makes it impossible for society as a whole to buy all the goods produced. This is their celebrated "paradox of thrift." The authors recognize the fact that money and credit are elastic quantities. Under some conditions they would expand them to make up for the amount withdrawn for savings.

A well-known English economist, J. Maynard Keynes, in his voluminous, brilliant, and difficult book "Money," resolves the paradox. He shows that the normal way in which savings are returned to purchasing power is through

"Keynes says in effect that when the rate of investment exceeds the rate of savings, business improves and prices rise; when the rate of savings exceeds the rate of investment, business recedes and prices fall. This statement would have to be modified somewhat to apply to American conditions."

the act of investment. By investment is meant new investment. Purchasing power is increased, and hence the tendency to maintain a balance between production and purchasing power is established, *if* the savings or moneys are used in investments, in new buildings, factories, homes, utilities, and other new wealth-producing activities.

As an example, it is probable that the general purchasing power of the country was maintained during the comparatively prosperous years from 1922 to 1926 by the rapid flow of millions of dollars of savings into the expanding automobile and other industries. Savings were not held out of purchasing power to any appreciable extent during that period, and thus purchasing power kept step with production.

According to another Englishman, J. L. Hobson (see especially his book "Rationalization and Unemployment") when too small an amount of the disbursement of wealth goes to those who earn wages and small salaries and too large an amount is paid those who earn large salaries and receive dividends, there is likely to accrue savings which cannot be invested profitably. In such a case the rate of savings exceeds the rate of investment and hence a business decline is initiated.

This general theory basically looks upon uninvested savings, of which there are hundreds of millions idle in the banks of the United States, as equivalent to unbought or at least unpaid-for goods. On the basis of this general theory, any increase in disbursements to the lower-paid classes is likely to broaden the market for goods. This is the American theory that good business requires high wages, a principle that the crash of 1929 reemphasized rather than disproved. However, it cannot be assumed that all money paid to American labor will go immediately into purchasing power because the aggregate volume of the savings of American workers is large.

Another important point is that the distribution of profits not supported by actual increased purchasing power gives an illusion of permanent prosperity. As a consequence, stocks rise, money flows into the stock market in preference to seeking lower returns from investment, and an uncontrolled and inevitably disastrous boom is on.

"The grim processes of normal recovery from a depression have been described as consisting of the gradual exhaustion of uninvested savings, the writing off of bad debts, and the borrowing of money on life insurance to sustain existence."

The grim processes of normal recovery from a depression were described by Virgil Jordan ("Economic Aspects of Stabilization," read before the American Society of Mechanical Engineers on Dec. 2, 1931) as consisting of the gradual exhaustion of uninvested savings, the writing off of bad debts, and the borrowing of money on life insurance to sustain existence. Other large scale operations of the same character and effect take place. When these painful processes of readjustment have proceeded so far that the purchasing power of the market exceeds current production and a lack of goods is indubitable, recovery commences.

Such appears to be, in its simplest terms, the nature of the typical business cycle, which in part is responsible for the current economic distress.

"Two similar depressions occurring in this country from 1820 to 1850 and from 1870 to 1895 were alleviated by the expansion of our western frontiers, new inventions, and the discovery of important new gold fields. Mining engineers now report that gold production is on the decline and that new strikes are unlikely."

A post-war Deflation of "secular" or long term duration is the second element in the present business depression. Not the least of the miseries and injustices of war is the fact that for financing such a struggle no means have been discovered that do not involve inflation and the arbitrary and unsound expansion of the amount of money in use. All of this is reflected in a rise in the general price level and an immense stimulation of business. After a war ends, inflation normally is followed by a compensating deflation which may be sharp or gradual, controlled or uncontrolled. The United States now is experiencing the effects of the World War deflation.

Deflations of the same type have occurred twice before in this country. From 1820 to 1850 there was a long-continued decline in the price level, characterized by bank failures, severe financial distress, three or four cycles of depressions, and political unrest. The discovery of gold in California in 1849 started a gold inflation, which is claimed to have started a period of recovery which lasted until the Civil War.

The second similar decline followed the mid-century wars of Europe and the United States and lasted roughly from 1870 to 1895. This period also was characterized in the United States by labor troubles, agricultural and political unrest, "greenback" difficulties, and a general retardation of business. It was in part alleviated in this country by the expansion of the western frontiers, by the development of natural resources, and by new inventions. This period was terminated by the discovery of gold in Australia, Alaska, and South Africa and the invention of the cyanide process of gold extraction.

The world now is experiencing a secular price decline arising from similar causes. In the two previous periods mentioned, the declines were arrested by new gold discoveries. The seriousness of the present situation is deepened by the fact that mining engineers feel very doubtful of any new large scale additions to the gold supply which would start a typical gold inflation; meanwhile the old mine workings are becoming less productive. The prospect is serious. Society does not prosper under a long continued deflation.

The agricultural crisis is typical of a post-war deflation, but in the United States agriculture is now burdened with new ills, particularly with regard to the great staples, wheat and cotton. Wheat is feeling not only the impact of the expansion of new

territories, in Canada and Russia, but also that of new varieties and processes. A similar extension of areas applies to cotton raising. This increase in production has met a decrease in demand brought about by the introduction of rayon and changes of fashion in women's apparel.

This is commonplace process, but nonetheless distressful. It is one of the elements responsible for the present economic situation in this country.

Reduced investment opportunities conceivably may result from the apparent fact that the initial task of equipping a mechanized society seems to be past the stage of rapid growth. Is it not possible that this country is sufficiently equipped with railways, steamships, factories, and mines to meet all of its reasonable needs for some years to come? There is of course much work to be done and many improvements to be made, but is it unlikely that the past rate of acceleration of investment in mechanical equipment can continue indefinitely.

It is easy to become unduly and prematurely alarmed in this matter, but such a possibility is in the minds of many engineers. If the opportunities for new investment should decrease appreciably, prosperity on the Keynes formula would become more difficult. However, a countervailing factor is that one of the results would be a permanent lowering of the interest rate, which in turn would broaden the field for profitable investment.

"Remedial activities must be of such a nature that they do not require a beyond-human knowledge nor a beyond-human skill in planning, to become measurably effective. Also, they must take human nature as it is found, employing its forces and desires and giving direction instead of applying compulsion. These considerations seem to rule out most of the five-year, ten-year, and twenty-year plans which have been presented recently."

Suggested Lines of Action

The foregoing analysis seems to cover the nature of the outstanding elements of the present situation. As already stated, the opinions expressed are not fixedly held; but are subject to review and change. It was for the purpose of suggesting effective action that this investigation of causes was undertaken. The present economic situation is complex, and its correction may be expected to be equally complex. There is no single action which will be effective over the entire area of the mal-adjustment. Such simplification as is possible will result from keeping clearly in mind the ultimate objective: *a standard of living for the United States that is high, broadly distributed, and free from severe fluctuations.*

If one could take a position sufficiently far above the surface of the earth and were possessed of sufficient keenness of vision to see from that point what is going on in the United States as a whole, he would observe rivulets of materials leading from farm, forest, mine, and ocean gathering into broad streams in their flow toward industrial establishments. Thence he would see the finished goods, flowing in smaller streams to wholesalers, then in still smaller streams to retailers, and finally, as subdivided particles, reaching ultimate consumers. If it were visible, there would be a similar, but reverse, flow of money and credit in its various forms. The extent, variety, and complexity of these operations are beyond human comprehension or calculation.

The guiding principle which now preserves order in this complicated situation is the profit motive, although it has become fashionable to argue that this force tends to become ineffective and soon may be discarded. The real function of profit goes deeper than motive; in our economy it is a fundamental requirement for continued existence, and never is long neglected without vital peril. It is the ruling condition which, when effectively met, permits the superposition of many other less impersonal motives. Its useful function is in providing a firm foundation for structures more spiritual.

Remedial activities. Two recent attempts have been made to bring this incomprehensible mass of economic transactions under control. The first was made by the U. S. War Industries Board during the World War. This task was simplified by the fact that there was but one customer, the United States; one objective, the winning of the war; unlimited resources, that is, the artificial extending of credit which goes with war inflation. The mechanism which served the earlier occasion will not serve this one. The other attempt at complete economic planning is that going on in Russia. This effort also has been simplified. It is based upon an allegedly temporary low standard of living.

The American people have established a going mechanism of money, credit, labor, and services which operates to direct the flow of that complexity of goods which the "aerial observer" saw. Right now, the mechanism is not operating properly. However, in view of the complexity of the processes and the degree of success with which it has operated, the decision must surely be to study its deficiencies, improve its organization, and lubricate its movements, rather than to discard it forthwith. This being the necessary and logical decision, it would be wise to start the study by looking first at governmental and general financial policies which affect large operations and large sums of money rather than by attempting to develop means for arbitrarily controlling the flow of separate commodities. In fact, the immediate problem is to answer the question: How can the rate of savings and the rate of investments be balanced?

Taxation may be used to secure the desired balance. By increasing taxes during one phase of the business cycle, excess savings may be decreased; by floating government bonds at another phase an opportunity may be provided for investing savings. One means by which this can be accomplished is by establishing the principle of long-term governmental budgeting.

Long-term budgeting is one of the new mechanisms of management that has resulted from a union of engineering and financial principles, and one recognized as essential to first class business man-

agement. For the government to attempt to balance its income and expenditure in each fiscal year is not in accordance with the principles of good management. The government should recognize that in the course of a business cycle there is a time to tax and a time to relieve taxation, a time to borrow and a time to repay, a time to expand money and a time to contract it, and a time to extend operations for public works and a time to contract them.

It would appear that if, when employment has reached a certain low point, a policy were followed of borrowing for extending public works, this action would have a quick remedial effect on the business situation. By drawing them into government activities, such governmental borrowing would serve to reduce the accumulation of savings seeking investment.

The time for taxation is when business is good and profits are being made. Taxation then, if taken from profits, has the effect of reducing the amount of funds seeking investment and flowing into speculative channels. The concurrent repayment of the sums borrowed in the earlier period of the cycle tends on the whole to contract currency and thus acts as a brake on that upward movement of prices that is one of the factors building up the speculative structure of a boom.

Furthermore, it does not appear desirable to lay aside reserves in prosperous times to spend on public works in dull times. Such an accumulation of funds would be embarrassing to the necessary balance between savings and investment. In large scale governmental operations it is preferable, contrary to the accepted principles of financial morality, to borrow, spend, and repay rather than to save and then spend.

To recapitulate, borrowing, public works, taxation and retirement of borrowing applied at such times, in such degrees, and in such ways as may be found by experience to be useful, will have remedial effects on the business cycle itself. Thus dangerous accumulations of idle funds (implying unsold goods) will be put to work, credit will be extended by the borrowing operations thus tending to raise prices at a time when they are otherwise in danger of a disastrous lowering, and work will be furnished; all three at a time when they are most needed. Also, the reduction of public works, increased taxation, and the payment of loans will release men required for extending industry, prevent dangerous accumulations of money which can find no profitable use and, at a time when most needed, will restrain an hysterical rise in the price level, with all the train of disasters which follow therefrom.

These policies are not capable of immediate application, hence cannot be used in the present situation. The period of borrowing on most favorable terms has passed, the needed governmental reorganizations of public works control has not been effected, and the study needed to coordinate the program has not been given. The possibilities outlined will not become fully available except as they are worked out in preparation for the next turn of the business cycle.

Non-competitive public works are contemplated. If the government simply does work that private institutions or individuals otherwise would do, no new avenues for expenditure or investment are opened. *New* avenues are required if there is to be a better balance between the rate of saving and the rate of investment.

Furthermore, state governments, counties, and municipalities also must so adjust their taxation and borrowing programs as to draw their required finances from savings seeking investment, rather than from such sources as will place a burden on the operations of buying, selling, and manufacturing. This points to a general expansion of the income tax policy, both individual and corporate, with perhaps a new emphasis on earned *versus* unearned income as against property tax, sales tax, and other similar policies. Some of these latter taxes, such as that on gasoline sales, are useful and easily collected, and their elimination is not urged. However, they offer no creative possibilities such as appear in the income tax.

"The stabilization of money is another possibility for large scale governmental and financial action. The seriousness of the lack of control of money value (or, the general price level as reckoned on a properly selected index) is beyond the power of words to express, because the world probably is in full movement on a secular decline with only minor short-lived upturns in prospect. It is important for governments and financiers to reconsider their attitudes on this question. A steadfast attempt to discover a safe and reliable means of controlling the value of money is required. Instead of being a question that is tabooed or ignored, it should be looked upon as the most important financial subject to which those in charge of the world's money can devote their energy and attention. There should be no rest until every possibility has been canvassed."

Centralized national public works control, for which American Engineering Council has been working for more than a decade, is necessary for carrying out the suggested program; likewise for the states, counties, and municipalities. While the suggested program may appear to require a larger amount of public works, borrowing, and taxation, than customary, this is not necessarily true. It is possible that no greater total expenditures will be required over the course of a single business cycle than has been customary.

The balance of international payments as published in the Year Book of the U. S. Department of Commerce, may be made a most valuable instrument in any system of control. This document, next to the internal balance sheet of the receipts and expenditures of the government, is the most important document prepared for the guidance of the general financial and business operations of this country.

A careful scrutiny of this balance sheet indicates that any further extension of foreign loans at this time is unwarranted on the basis of any practical possibility of increasing the counter-balancing items. A further disregard of these implications may lead to such serious involvements in foreign conditions

as to make the recovery in this country less assured and decided, and that without compensating advantages to the world situation. The duty of those in control of the international financial operations of this country clearly lies in keeping a close eye on the balance of international payments to the end that no greater credit extensions be made than can be repaid by imports, foreign travel, and the like.

In the event world conditions should become increasingly chaotic, the organization of world finance and commerce will be best initiated in the smaller units of the national economic empires. The British Empire furnishes one such example and the United States and its dependencies another. Such limited organizations having non-predatory attitudes toward the rest of the world may offer the best hope for world progress in the immediate future.

"Decentralization of manufacture offers a useful method of striking a balance between agriculture and manufacturing. Only a few industries, such as that engaged in steel production, must be organized on a scale so large as to surround themselves inevitably with urban conditions. The present tendency to locate units in smaller communities should be encouraged for the sake of human as well as business values. Besides offering a greater stability to the life of the workman through the opportunity for gardens, poultry yards, and the like, it also furnishes a marginal region in which any needed interchange of manpower between manufacturing and agricultural activities could be made as changing conditions might require."

Tools of control for the needed international flow of goods and credit lie in the government's supervision of the extending of foreign credits, and in the application of the tariff. Both the tariff and the control of credits should be viewed from the standpoint of this total situation in a way in which they do not appear to have been viewed in the past.

The condition of agriculture does not lend itself so readily to practical recommendations as do some of the other elements of the general economic problem that have been considered. However, to no other group would a stabilization of money be more helpful than to the farmers whom the deflation hit in full force long before it was felt by other industries. Agriculture has no inherent self-protection.

Government reclamation policy should be considered from now on with great care. No new areas should be brought under cultivation with public funds until every aspect of the resulting increased production has been canvassed. In fact, instead of reclaiming lands, it is possible that the government should be locating and purchasing marginal farm lands which should be reforested. This possibility already is being canvassed to some extent by the federal and state governments. It could be carried on and financed, by proper timing in the business cycle, in such a way as to improve the general situation.

Profitable investment opportunities must purposefully be searched out if this country actually is nearing a saturation point in mechanized equipment. Heretofore the demands for capital to supply new construction and manufacturing activities have absorbed the money available for investment.

What is there now of this same sort that will draw into profitable industry the idle millions of the years to come? Will it be the building of houses? If so, the cost of their construction will have to be diminished by new methods and by a better equalization of labor rates as between the building trades and those whom the buildings are to house, with due consideration to the annual earnings of building trades labor. When the investment market accustoms itself to a lower rate of return, capital will flow into this channel. Furthermore, the increased standard of living contemplated will enlarge the market for household furnishings, equipment, and conveniences.

Increased investment also is possible in small items totaling a large amount. Engineering analyses of the advisability of investments in new equipment by industries well established and running may well become a vital link in the maintenance of general economic prosperity in this country. The recognition of this by financial authorities and their organization to finance the multitude of small investment required may, in the aggregate, furnish a sufficient channel for investment to answer for many years the purposes of sustained prosperity. To make this effective, however, financial leaders must recognize the economics of the situation, and must consciously organize for this specific purpose. A helpful procedure would be to set up in each banking organization an engineering staff which should be as aggressive in searching for opportunities for sound investment as the sales departments have been in enlarging the lists of depositors.

This discussion again raises the question of *public works*. Herein lies an almost limitless field for the investment of private savings for public good that is socially profitable and economically stabilizing. To some extent the requirements may be realized and met by private initiative, but to a large extent it will have to be done by taxation. Moreover, it is in the interest of general business, when the rate of saving is larger than the rate of investment, to withdraw money from private hoarding and to use it for the public benefit. This is true because it is becoming plainly evident that money which is neither spent in consumption nor invested in capital goods is impotent in the hands of the one who saves. It does not benefit the saver, and it does injure society.

Pensions, unemployment insurance, life and disability insurance, and other similar industrial proposals deserve most careful study. The necessity, however, for such—private relief as is suggested, particularly unemployment insurance—will diminish in proportion to the success of the governmental action outlined herein.

Trade associations should be developed further. They should not only be permitted, but compelled to gather the basic information relating to their industries and to make public frequent and detailed reports on output, sales, stock in hand, unfilled

orders, cancellations and capacity utilized. Such information would assist in planning everything that can be done industrially to maintain a steady flow of business. Ignorance of or inattention to such information in the past has resulted in entire industries adopting unwise policies which have contributed to economic unbalance. Sound methods should be developed for the introduction of new processes and machines into its field, so that industries may make needed changes with minimum economic disturbance and distress to individual workers.

Trade associations might profitably be required to set up not only standard principles and uniform methods for cost keeping, but also standard practises for financial reports to stockholders. Financial reports should be made public even though the securities of the companies are neither listed nor held by the public. Such a provision would encourage new money to flow into those fields where investment is likely to be profitable, rather than into those where a loss may be easily incurred. Associations should make a thorough, continuing study of consumer credit and installment selling. It would be most useful, at any given time, to know: whether installment buying were increasing or decreasing, whether payments were prompt or delayed, the proportion of returned goods. Information of this character would be exceedingly useful in developing policies of economic control.

A shorter work-week should receive the serious consideration of industry and commerce. The distribution of wealth between consumers and investors probably could be much improved by adopting new working hours and new overtime policies. For instance, it is reasonable to believe that if in an industry normally operating 50 hr. a week the working hours were shortened to 40, with 50 per cent overtime pay up to 45 hr. and 100 per cent overtime pay beyond that, the influence of the change would be in the direction of maintaining good business because:

1. Shorter normal working hours would constitute a permanent "spread of employment."

2. As business improved and the number of hours became too small, the overtime rate effective up to 45 hr. a week would assist in increasing the distribution to consuming power necessary to maintain the increased business. The extension of working time to where 100 per cent for overtime applied would add still more to consuming power.

3. The cumulative overtime would act as a damper to unwise expansion of activity. The business man would calculate more carefully before allowing rein to his enthusiasm. When he did conclude that the increased overtime was necessary his decision would be justified by the added consuming power involved.

Such a policy would have to be on an industry-wide basis, or the progressive and socially minded employers would be at a serious disadvantage.

Employment agencies, in a thoroughly coordinated country-wide system and with a well-trained and efficient staff, are essential. This is a pressing, unfilled need. Employment is a highly specialized problem and one of vital importance to any plan of controlling economic forces.

Production by agreement to reduce output, or the allocation of business to different firms is an unwise policy under normal business conditions. Such arbitrary control leads inevitably to stringent government regulation and official price fixing.

General Observations

Although the issues discussed in this progress report have not been thoroughly studied, they comprise the broad outlines of the problem of economic balance, and they are subject to determination. There is an evident need for a more detailed and exhaustive consideration of them, and of others not mentioned.

Arbitrary control of modern industry and commerce in all their ramifications, complexities, and details, clearly is beyond the power of human beings; influences now at work must continue to govern its details. In particular, the profit motive and the active force of competition must be retained in such effective operation as will give society the benefit of the continuous improvement in methods and lowering of costs which they are capable of giving, but they must be restrained in their destructive and unsocial manifestations.

Since uncontrolled development has brought about so many undesirable results, there is justification for taking such chances as may be involved in developing rationally controlled economy. However, experimentation in social matters is serious, and therefore must proceed with wisdom and caution. The problem of the relation of consumption, production, and distribution is one of supreme importance and world-wide scope. There is no human problem which compares with it in difficulty, magnitude, or hopefulness. More and more, it must command the attention and devotion of the most intelligent, unselfish, and far-seeing men and women of the body politic.

"What is being contemplated is nothing less than the purposeful changing of the course of history. To such an undertaking the highest human capacities of our time must devote themselves."

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Skyline of Vancouver, B. C., Host City to the 21st Pacific Coast Convention, August 30 to September 2, 1932

Telephone Handset a Product of Research

Many problems had to be solved before the handset type of telephone, now so popular with the public, became a practical reality. This article tells how some of these problems were solved, and how the characteristics of the present handset differ from those of the desk stand instrument.

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ALTHOUGH the idea of mounting a transmitter and receiver on a common handle to form a handset was conceived soon after the invention of the telephone, and although handsets were in use by operators as early as 1878 only recently has it been possible to realize the convenience of this form of telephone set in the Bell system without undue sacrifice of performance as compared with the desk stand. For this reason the telephone system in this country has been built up in general around the desk stand which permitted the utilization of the available instruments to best advantage.

The greater difficulties inherent in the design of a handset as compared with a desk stand are due partly to a difference in the use of the instruments and partly to necessary differences in structure. The controlling difference in the use of the handset is due to the greater freedom permitted the user; this results in a wider range of positions for the transmitter, with a consequent tendency toward much greater variations in transmission characteristics and resistance. These variations may render the transmission unsatisfactory, and also may interfere with the operation of associated signaling and switching apparatus. The more severe handling of the handset transmitter also tends to accelerate aging.

Practically all commercial telephone sets are of the so-called "invariable" type in which the transmitter and receiver are connected to the line at all times while the set is in use. Therefore, part of the transmitter output is conducted to the local receiver; in addition the instruments are coupled to some extent through the air and, in the case of the handset, mechanically through the handle. If the amplification afforded by the transmitter is greater than the total losses in this side-tone path of receiver, air, and handle, sustained oscillation or "howling" may be set up. This condition is of course fatal to transmission; in practise it is necessary to operate well below the howling point to avoid serious transmission impairment from transient oscillations.

The handle of the handset definitely establishes the distance between transmitter and receiver: If it is too short, the user may not be able to hold the receiver on his ear with the transmitter in front of his lips; if it is too long, a transmission loss is introduced by the unnecessarily great distance between the transmitter mouthpiece and the user's lips. If the convenience of the handset is to be realized fully, the handle must be comfortable to hold and the complete handset must be light to avoid fatigue on the part of the user.

While many incidental problems have required solution during the development of the handset shown with its mounting in Fig. 1, this design is largely the result of a systematic attack upon the more fundamental problems which have been discussed. In describing the handset and its characteristics particular attention will be given to the features of importance in the solution of these problems.

Transmitter Construction and Characteristics

The transmitter is assembled in a die cast aluminum housing forming a unit which mounts in a threaded bushing in the handle. (See Fig. 2.) The molded phenol plastic mouthpiece, dome, and spacing ring insulate the electrical circuit from possible contact with the user. The carbon chamber of the transmitter is of the barrier type and differs materially from the ordinary direct-action type employed for years in desk stand transmitters. As may be noted, the diaphragm is insulated from the carbon. Both electrodes are stationary and are separated by a ceramic barrier; the electrode adjacent to the dia-

Fig. 1. Telephone handset now in use, with dial type mounting

Based upon "The Development of a Handset for Telephone Stations" presented at the A.I.E.E. winter convention, Jan. 25–29, 1932.

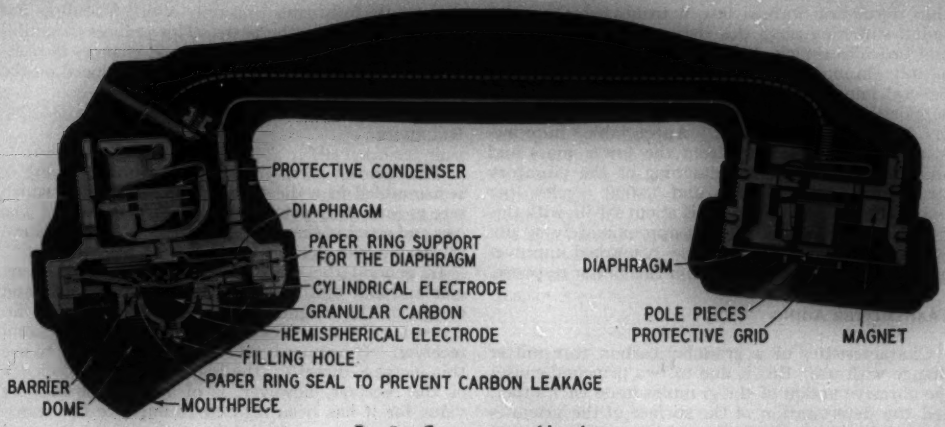

Fig. 2. Cross-section of handset

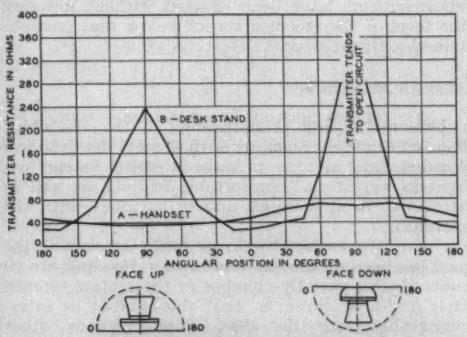

Fig. 3. Effect of position on resistance of handset and desk stand transmitters

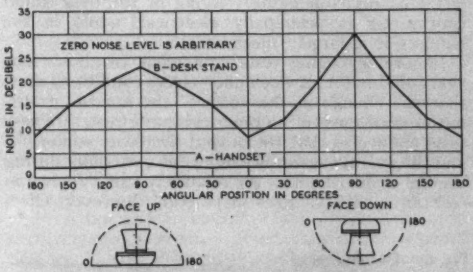

Fig. 4. Effect of position on carbon noise of handset and desk stand transmitters

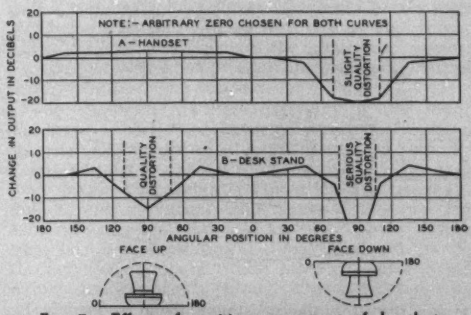

Fig. 5. Effect of position on output of handset and desk stand transmitters

phragm is cylindrical; the other, hemispherical. This arrangement insures good contact between the carbon granules and electrode surfaces, and between the granules themselves, for all of the positions in which the transmitter is likely to be held. The resultant uniformity of resistance with position as compared with the conventional form of desk stand transmitter is shown in Fig. 3.

Low and relatively uniform carbon noise results from the uniform contact pressures and resistance of the handset transmitter. It may be noted from Fig. 4 that the carbon noise of the desk stand transmitter under handset conditions would be from 5 to 30 db. greater than that of the handset transmitter.

One of the unique features of the new handset transmitter is the location of the carbon chamber in front rather than in back of the diaphragm. By this arrangement the carbon granules are held in contact with the diaphragm in all positions of ordinary use; uniform output and faithful reproduction of speech sounds thus are obtained. In Fig. 5 is shown the difference between the output obtained with this transmitter and that secured with the desk stand direct-action transmitter.

The diaphragm of the transmitter is made from

thin duralumin formed into a truncated cone with radial stiffening ribs; this reduces its effective mass and provides sufficient rigidity to insure vibration as a unit throughout the operating frequency range. Several impregnated paper rings provide a resilient support for the diaphragm and add a certain amount of mechanical resistance. Appreciable improvement in response results from the lower mass and stiffness and the higher damping of the vibratory structure. Between 300 and 3,000 cycles per second the range in response is about 20 db. with this transmitter as compared with approximately 40 db. for the desk stand transmitter. A marked improvement in articulation results from this better response.

Transmitter Aging

Characteristics of a granular carbon transmitter change with use; this is due to two principal causes the abrasive action of the granules upon each other, and the deterioration of the surface of the granules from high temperatures caused by excessive contact voltage. The former is known as *mechanical*, the latter as *electrical* aging. Aging of the desk stand transmitter is principally electrical, while in the handset it is largely mechanical.

Laboratory aging tests equivalent to about four years of handset service under severe conditions show that the change in the noise of the handset transmitter with age is of no practical importance. These tests show also that the output decreases somewhat and the average resistance increases materially during the life of instrument; the relatively small change in resistance with changes in position, however, effectively prevents the resistance from frequently becoming high enough to interfere with the operation of signaling apparatus in circuit with the transmitter. In this respect the new transmitter represents a notable improvement over earlier types.

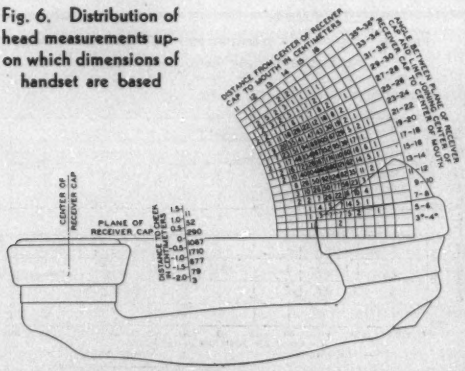
DISTANCE FROM CENTER OF RECEIVER CAP TO MOUTH IN CENTIMETERS
ANGLE BETWEEN PLANE OF RECEIVER CAP AND LINE FROM CENTER OF RECEIVER TO CENTER OF MOUTH PIECE
CENTER OF RECEIVER CAP
PLANE OF RECEIVER CAP
DISTANCE BETWEEN PLANE OF RECEIVER CAP AND LIPS IN CENTIMETERS

Fig. 6. Distribution of head measurements upon which dimensions of handset are based

Method of filling the handset transmitter contributes materially to keeping the aging rate low. A machine taps the transmitter while it is being filled with carbon granules, so that the chamber is filled practically full instead on only about $^{3}/_{4}$ full as has been customary in the past. This reduces to a minimum the motion of the granules and changes in resistance which occur when the handset is placed on the mounting.

Receiver

The handset receiver as may be seen from Fig. 2 is assembled in a die cast aluminum housing which screws into an insert in one end of the handle. The cap and spacing ring are of phenol plastic; they serve to insulate the electrical circuit from the user.

In general the receiver has been designed along conventional lines, but the choice of materials and design of the magnetic circuit have resulted in increased efficiency compared with the desk stand receiver. It has not been considered desirable to use this increase directly; the higher inherent efficiency of the receiver, however, is of appreciable indirect value for it has been utilized to improve the transmitting and receiving characteristics of the set, and to increase the stability of the receiver. These improvements have been effected without lowering the level of the received speech below that now obtained with the desk stand.

Assembled Handset

Dimensions and proportioning of the assembled handset represent an effort both to meet the technical requirements and to produce a sturdy structure, light in weight and comfortable to hold, as well as attractive in appearance and in harmony with the mounting.

One of the major objections to the handset in the past has been its tendency to howl. Howling can be controlled in part by changes in the station circuit. It is desirable, however, that the handset be interchangeable with the desk stand without other changes in the telephone plant; therefore it has been designed to be inherently free from howling.

The solid phenol plastic handle employed in the present handset has a relatively high resonant frequency and provides a comparatively inefficient medium for transmitting between receiver and transmitter disturbances in the frequency range where the instruments respond most readily. Another factor in eliminating howling is found in the characteristics of the transmitter; its light and highly damped diaphragm does not respond readily to vibration set up by the receiver and transmitted through the handle, and under the worst conditions a margin of at least 15 db. against howling is realized with this structure.

Care has been taken in proportioning the handset to avoid an unnecessarily great distance between the lips and mouthpiece and to provide adequate clearance between the cheek and handle. Approximately 4,000 head measurements were made to determine the proper dimensions; these data are summarized in graphical form in Fig. 6. All but about 3 per cent of the persons measured can use the handset by holding the receiver to the ear in the usual manner; the others can do so by a slight shift of the receiver on

the ear. The effect of this shift on the receiver speech is negligible compared with the average improvement in transmission resulting from the reduction in average talking distance.

Performance in Service

Since the initial introduction of the handset, close contact has been maintained with its performance by tests and observations under actual service conditions, and by examination of instruments returned from service. These observations have shown that, although as used by the subscriber the output of the handset transmitter to the line is somewhat lower than that of the most efficient desk stand transmitters, the improved response and articulation are adequate compensation for the lower level. Transmission performance of the handset has been found to be as good as, and probably on the average somewhat better than, that obtained with the desk stand.

Undesirable variations in transmission and resistance with change in position, excessive carbon noise, and howling, all of which heretofore have presented serious obstacles to the adoption of a handset for general use, have been overcome successfully in the design described. It has been found practicable to use this handset interchangeably with the desk stand in the existing telephone plant without important reactions on either transmission or signaling performance.

Commutation—

A Switching Phenomenon

Ideal commutation of armature currents can be obtained in but very few practical cases. In all others, a spark occurs at both the leading and trailing edges of the brush, and the introduction of the concept of switching assists in explaining this phenomenon. A brief analysis of the various considerations entering the problem is given in this article.

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COMMUTATION theories usually deal with the reversal of the current in the commutating coil and with means for bringing about such reversal either along a straight line or a curve. The principal object in such studies is to accomplish commutation without excessive current densities under the brush. It is recognized that frequently it is impossible to realize this, but little attention has been paid to the fact that unless such ideal conditions are obtained, we actually have to deal with a switching phenomenon and that the problem should be analyzed with this in mind.

Let us assume that the circuit of armature coil 1 in Fig. 1 is about to be short-circuited by brush B and that at this moment a voltage e is induced in the coil by its rotation in the commutating field, or possibly by the stator field of an a-c. machine. It is evident that sparking in the minute point or edge of the brush B which first touches the segment a will be influenced largely by the speed with which the circulating current in the coil can build up as compared with the rate of increase of the area common to the brush and the segment a. This in turn means that the speed of the commutator will have an influence as well as the rate of increase of the circulating current. The latter is determined by the voltage e and the self-inductance and resistance of the circuit of coil 1, if the coil carries no flux common to other closed circuits. This condition would exist if brush B does not short-circuit any other armature coil and if the field winding F is open-circuited, and under the further assumption that there are no secondary damping currents in the stator structure. Under these conditions the entire main flux F and the leakage fluxes L_a cause a rather high self-inductance in the armature coil 1, and consequently a slow building up of the circulating current. Fig. 2 represents a circuit equivalent to the armature coil 1 with the assumptions made so far.

The conditions change materially if the shunt winding F is connected across the armature circuit as shown in Fig. 1, as well as across certain load circuits L and various circuits of the generator G. We now have within the armature coil a leakage reactance flux L_s and a mutual inductance M between the armature coil and the field circuit. The latter in turn has a leakage flux L_f, and is closed partly through the armature circuit having resistance and inductance, and partly through several other circuits also having a resistance or inductance, or both; in other words, we have equivalent circuits somewhat as illustrated in Fig. 3. The rate of change in the circulating current now will depend upon all these factors, and therefore any change of constants in the field circuit or any of the other circuits may have a certain influence upon the commutating conditions. Similarly, any damping currents which can be induced in the solid portion of the stator yoke, or in coil

Based upon "Commutation Considered as a Switching Phenomenon" (No. 32–33) presented at the A.I.E.E. winter convention, New York, N. Y., Jan. 25–29, 1932.

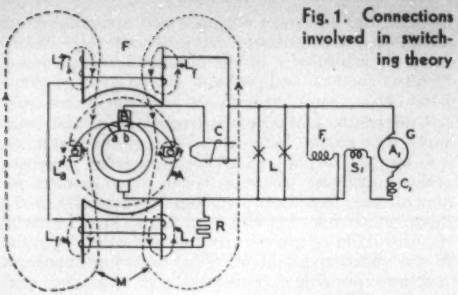


Fig. 1. Connections involved in switching theory

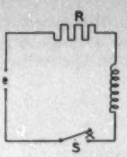
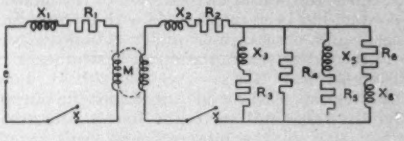


Fig. 2. (Left) Equivalent circuit of armature coil 1 shown in Fig. 1

Fig. 3. (Below) Equivalent circuit of armature and field plus external load and generator circuits



shield or damper windings surrounding the poles, may have an influence upon commutation. The various resistances and reactances shown in the secondary circuit of Fig. 3 are replaced by a single inductance X_2 and a single resistance R_2 in Fig. 4, which, while not fully equivalent to Fig. 1, somewhat simplifies the problem.

Opening the Circuit

All the various constants previously mentioned will have an influence also when the circuit of the coil 1 is opened while a circulating current is still flowing in it. There will be one difference, however, in that the high leakage and self-inductances helpful in the case of closing the circuit will be harmful in the opening because they considerably increase the energy to be dissipated in the spark which forms at the trailing edge of the brush. Mutual inductance, which aids in opening the circuit, as will be explained, is disadvantageous when the circuit is closed, since it allows a rapid building up of current. The effect of inductance on the opening operation may be made clear by following the switching operation in detail first for a machine with open stator circuits wound with one coil per slot, and a brush spanning one commutator bar, so that no account need be taken of mutual inductance between a commutating coil and any other closed winding. A circulating current is assumed to be flowing when coil 1 passes from under the brush.

When a circuit containing resistance and self-inductance such as shown in Fig. 2 is opened by the separation of contacts, in this case the brush and the bar, an arc or spark will be formed between the electrodes because at the last point of contact the temperature may become very high and "explosions" take place at this point, giving rise to sufficient energy density to establish the cathode spot of an arc on the negative electrode. As the contacts separate further the arc becomes longer and finally becomes unstable and vanishes. Any calculation of the decrease to zero of the circulating current due to commutator bars passing from under the brush must consider this short arc or spark formed. The arc characteristic, *i. e.*, the arc voltage as a function of the current through it, depends on the arc length. The latter in turn is varying and depends upon the way in which the arc is lengthened as a function of time; in other words, upon the speed of the commutator.

If the transient arc characteristic for a particular condition is known accurately, the energy dissipated in the arc can be calculated. This energy may be divided into two parts; the energy stored electromagnetically in the circuit, and the energy supplied to the circuit for the duration of the arc. In the case of the commutating coil, the latter energy may be supplied by the voltage induced in the coil by its rotation in the commutating field, or in an a-c. machine it can be induced also by transformer action between the stator field and the coil. Usually the total arc energy will lie between the values of once and twice the energy stored in the magnetic circuit. This stored energy varies directly with the self-inductance coefficient L and the square of the current to be broken; hence the arc energy also depends upon these factors. The length of time during which the arc or spark is present also increases with an increased coefficient of self-inductance. Since a trailing edge spark is harmful in so far as it burns the commutator and brushes, it is desirable to keep the energy to be dissipated in the spark as low as possible. This can be done by lowering the self-inductance or reducing the current to be interrupted; also by the proper utilization of mutual inductance.

Effect of Mutual Inductance

As previously indicated, circuits having mutual inductance with a commutating coil are established by the field or stator circuit being closed through the armature and other circuits, or by damping currents in the stator structure. Other circuits having mutual inductance with the commutating coils usually exist if the winding is chorded, if there is more than one coil per slot, or if a wide brush is used; in fact, whenever the sides of at least two coils which are being commutated during a common time interval lie in the same slot. In this case the mutual inductance between coils must be considered. For example, if the brush is wide as shown in Fig. 5 and short-circuits the two armature coils 1 and 2, coil 1, which is about to be open-circuited, still has leakage fluxes L_1, but it also has mutual fluxes M with the field winding as previously described, and mutual fluxes M_a with the armature coil 2, the latter in turn having leakage fluxes L_2 of its own.

This may better be shown by the simplified although not fully equivalent circuit indicated in Fig. 6.

If such a circuit containing mutual inductance in addition to self-inductance and resistance is opened with a switch, the decrease of the current in the primary circuit again may be calculated if the transient arc characteristic curve is known. It is found that in this case all of the stored energy need not be dissipated in the switch. The decrease of current in the primary circuit will induce voltages in the secondary circuits such as to cause their currents to change. This means that part of the energy stored in the primary circuit may be transferred to the secondary circuits and dissipated as I^2R loss in them or held in storage in the secondary circuits. Consequently, the energy dissipated in the spark may be, and usually is, reduced by introducing mutual inductions. The magnitude of the reduction depends upon the degree of mutual coupling between the circuits and upon the circuit constants, such as resistance and self-inductance, of all the circuits having mutual inductance with the commutating coil. It follows therefore that as conditions in the stator circuits change, the commutating condition may change also, although such factors as load current, speed, and commutating fields, which are usually considered as the only ones determining the commutating conditions, remain unchanged.

For similar reasons, different conditions of mutual inductance between the various armature coils will have an appreciable influence. The conditions of the mutual flux M_s and leakage fluxes L_1 and L_2 in Fig. 5 will of course be appreciably different when the coils are located in separate slots than when the coils are located in the same slot. This difference leads to the frequently observed condition that certain commutator segments show more burning than others. These considerations also explain why frequently a split-throw of the armature coils improves commutation as a result of its effect upon the relation between leakage and mutual inductances of the coils. Without the split-throw a good transfer of energy from coil to coil in the same slot may take place, but the last coil in the slot is not well coupled to the first coil in the next slot; hence considerable energy must be dissipated when the circuit of the last coil in a slot is broken. The split-throw reduces this maximum dissipation of energy in the spark because at least one coil side of the coil under commutation is always closely coupled with another coil side; and assuming that the brush is wide enough to short-circuit the adjacent coil, better transfer of energy can take place. The beneficial effect thus produced consists not only in decreasing the maximum sparking but also in bringing about more uniform sparking on the different commutator bars, which in turn reduces irregular wear and differences in the heating of the bars; irregular heating of the bars if occurring to any marked extent is likely to cause differences in expansion of the bars and therefore mechanical irregularities in the commutator surface, with consequent further accumulative harmful effects upon commutation.

In all of the previous discussions upon the constants of the circuits which may influence commutation, only resistance and reactance have been mentioned. However, with the high frequencies of commutating currents, it is quite possible that at times certain capacity effects in the various circuits may exert an influence upon commutation conditions.

Having established the new concept of switching and the fact that the various machine and external circuits may have an influence upon commutation, a means has been found for explaining many other practical experiences which cannot be explained by the conventional commutation theories. It may be seen readily, for instance, that there may be a difference in commutation between shunt, series, or separately excited machines, between laminated or solid field structures, etc., although the speed, current, and commutating field are the same. It follows that in the case of a-c. commutator machines the commutation may be affected by the size and type of transformer to which the machine is connected and by various other factors.

Interesting results may be obtained with two series-connected motors on a motor car, especially in a-c. motors having no damping effects in their field structure. If in such a case the commutating impulses transformed into the fields of the two motors are exactly in opposition, no damping current can flow in the fields. Such opposition of voltages will occur if the relative position of the two commutators is such that the brush edge in one motor lines up with the mica insulation while in the other motor it happens to be in the center of the bar. If the relative commutator position changes so that the brushes in both motors will have the same position with regard to the mica insulation, the commutating impulses reflected in the fields will be in phase and damping current can flow, thus causing conditions entirely different from those previously mentioned. With two such motors on a motor car having slightly different speeds caused by a difference in the wheel diameters, periodic variations of commutation will take place. With the two motors connected in parallel across the same transformer, similar variations may take place. Even a change in design from

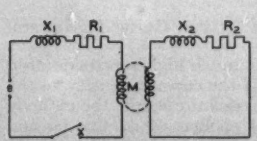


Fig. 4. (Above) Simplified diagram of the equivalent circuit shown in Fig. 3

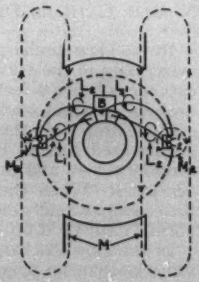


Fig. 5. (Right) Armature connections with two coils short-circuited by one brush

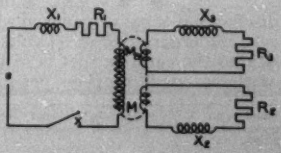


Fig. 6. Simplified equivalent circuit of Fig. 5

series to parallel connected fields in the motor may influence commutation. With such machines as phase-advancers or regulating machines connected to the secondary of induction motors, the switching theory readily explains differences in commutation which have been observed by the authors for different connections of such machines to various external circuits.

The introduction of the switching concept into the commutating problem is of course not necessary when ideal commutating conditions exist. There also are cases which approach the ideal sufficiently to make the consideration of the switching concept unnecessary in practise. Again, where the commutating conditions are not ideal but where the brush short-circuits several armature coils, their mutual effect may be so predominating that the characteristics of the field and external circuits may have little influence. In general, however, the commutating phenomenon cannot be considered as completely analyzed unless the possibility of the switching phenomenon as influenced by the various circuits has been given due consideration.

Cathode Drop in Arc Discharges

There is no general agreement among physicists concerning the mechanism which produces a low cathode drop with the correspondingly high current density which is characteristic of an electric arc. Herewith is presented a review of prevalent theories regarding this phenomenon, and results of some experiments on arc and glow discharges.

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AN ARC is defined as an electrical discharge in a gas or vapor in which the cathode drop is of the order of 10 or 20 volts and the current density to the cathode spot is of the order of hundreds or thousands of amperes per square centimeter. In order for an arc to exist it is necessary that there be some mechanism for producing electrons at or near the cathode. As to the way in which these electrons are liberated there are three theories as outlined briefly in the following paragraphs.

1. Thermionic emission. This, the oldest theory, assumes that by the bombardment of positive ions the cathode spot is maintained at such a temperature that it is capable of emitting sufficient electrons to maintain the arc. For this to take place temperatures greater than 3,000 deg. cent. would have to exist at the cathode spot. These temperatures actually do exist in the case of the carbon and tungsten arc; but in arcs between less refractory metals such as copper or brass as well as in the mercury arc, no such temperatures are present at the cathode spot. In such cases thermionic emission cannot account for the liberation of sufficient electrons to maintain the arc.

2. A more recent theory is that positive ions are present close to the cathode in such large numbers that they produce an electric field sufficiently large to free electrons from the cathode by the attraction of the field alone. Calculations show that electric fields of the order of 10^6 volts per cm. exist at the cathode in the case of both copper and mercury arcs; these fields are large enough to supply the electrons necessary for maintaining the arc.

3. A third theory proposes that the production of electrons is due to thermal ionization of the gas near the cathode. In order that there should be any appreciable thermal ionization in the gas, the temperature of the gas must exceed 4,000 deg. cent.; it is doubtful if such a high temperature obtains.

It seems probable therefore in the case of arcs between highly refracting electrodes, such as carbon and tungsten, that electrons are emitted from the cathode by thermionic action. In the case of arcs between less refractory electrodes such as copper or brass, electrons probably are emitted from the cathode by the action of the intense electric field existing at the cathode surface.

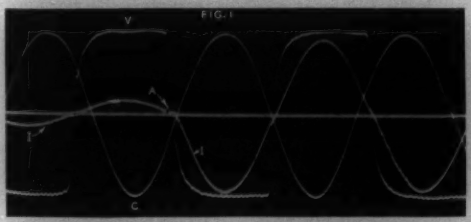

Fig. 1. Current and voltage relations in the abnormal cathode drop; at point A the current was increased suddenly from 52 to 320 milliamperes

Normal Cathode Drop in the Glow Discharge

In the glow discharge a much higher cathode drop exists than in the arc. If the current density to the cathode is below a certain definite value, the cathode drop is constant and is spoken of as the normal cathode drop. As the current density to the cathode is increased further the magnitude of the cathode drop increases, and the region over which it extends decreases. When the cathode drop increases with increasing current density it is spoken of as the abnormal cathode drop.

In the glow discharge as in the arc there must be some mechanism present to produce electrons at or

Based upon "Cathode Drop in Arcs and Glow Discharges" (No. 31M5) presented at the A.I.E.E. Pacific Coast convention, Lake Tahoe, Calif., Aug. 25-28, 1931.

near the cathode; the following theories have been proposed:

1. Positive ion bombardment of the cathode. It is known that electrons may be liberated by positive ion bombardment of a metal surface; however, when the normal cathode drop obtains it is doubtful if the positive ions hit the cathode with sufficient energy to produce any appreciable ionization; but when the cathode drop is abnormal, the positive ions possess much more energy, and under these conditions this mechanism may be the most important one.

2. Production of electrons by collision of positive ions with neutral gas molecules in the region of the cathode drop. In general this process occurs only when the positive ions possess energy greater than in the normal cathode drop.

3. Production of electrons from the cathode by photoelectric effect. It is believed generally that this process is inadequate to account for the required number of electrons necessary to maintain the discharge.

4. Production of electrons by metastable atoms arriving at the cathode. Because one of the electrons is in a high-energy level, these metastable atoms have enough potential energy to free electrons from the cathode. It is probable that in the case of the normal cathode drop this mechanism is important, especially when the rare gases such as helium, neon, or others are used.

Unfortunately, so far none of these theories has been developed so as to obtain quantitative agreement with experimental results. It is possible that two or more of these processes may take place simultaneously; also in some cases one of them may be most important, whereas in other cases another may be more prominent.

Abnormal Cathode Drop

As the current to the cathode of a discharge tube is increased in the region of the abnormal cathode drop, the magnitude of the cathode drop increases and the distance from the cathode in which the cathode drop exists decreases. Both of these effects cause an increase in the electric field existing in the cathode drop. It is quite certain that as the current is increased, a greater portion of the current to the cathode is due to electrons leaving the cathode.

For the past several years considerable experimental work has been done on the abnormal cathode drop; the results of a few of the experiments are presented here. Preliminary measurements of the cathode drop, especially when the current to the cathode was large compared to that required to just cover the cathode with the cathode glow, gave quite inconsistent results. The first measurements were made with direct current, but soon it was found better to use alternating current and measure the cathode drop with an oscillograph.

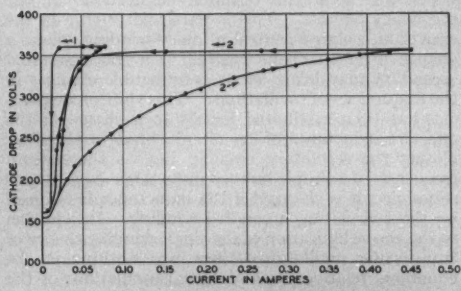

Fig. 2. Voltage of Fig 1 plotted against current

In Fig. 1 is an oscillogram which shows the relation between current and voltage in the abnormal cathode drop. Curve *I* represents the current through the tube, *V* the voltage across the tube, and curve *c* a calibration curve which in this discussion may be disregarded. At point *A* a resistance in series with the tube was short-circuited so that the current was increased from 52 to 320 milliamperes

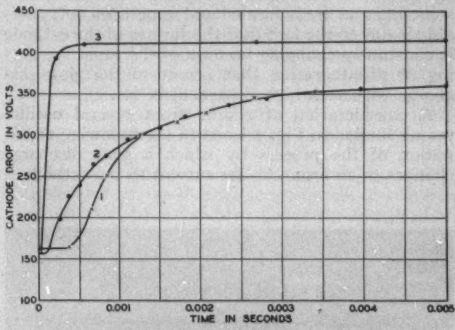

Fig. 3. Voltage of Fig. 1 plotted against time

(r.m.s.). It is apparent at once that this change in current has only a small effect upon the voltage curve.

In Fig. 2 the data from Fig. 1 are plotted with voltage and current as ordinates. This curve shows that the cathode drop is less for increasing values of current than it is for decreasing values. In Fig. 3 the data from Fig. 1 are plotted with cathode drop and time as ordinates. Curve *1* represents the data for increasing current when the effective value of the current is 52 milliamperes; curve *2* for a current of 320 milliamperes, and curve *3* for a current of 4 amperes. The difference between curves *1* and *2* for low values of time can be explained by the fact that the abnormal cathode drop occurs at an earlier time when the current is high than when it is low. If allowance for this is made it is apparent that the cathode drop requires approximately the same time to build up in the two cases where the current is 52 and 320 milliamperes, respectively. Curve *3*, however, shows that the cathode drop builds up much more rapidly when the current is high; this difference is explained as follows: In the case where the current is low, the cathode drop is formed by the positive ions from the main body of the gas congregating near the cathode, a relatively slow process. When the current density to the cathode is high, the cathode drop is due to the ionization of gas molecules near the cathode caused by electrons leaving the cathode and by the rapid dispersion of electrons away from the neighborhood of the cathode. Since electrons move hundreds of times more rapidly than positive ions,

this latter process takes place much more rapidly. This leads to the conclusion that when the current density is high, a large part of the current to the cathode is carried by electrons leaving the cathode.

Transition From Glow to Arc

The transition from a glow discharge to an arc is illustrated by Fig. 4. When this transition occurs, the voltage (curve V) shows a sudden decrease which corresponds to the decrease in cathode drop. Current through the tube is represented by curve I; its effective value was 4 amperes. The fact that sometimes an arc is formed and sometimes not, probably is due to the fact that the surface of the cathode is constantly changing because of the rapid sputtering or disintegration that occurs in the glow discharge with such high current densities.

A consideration of results from several oscillograms similar to Fig. 4 leads to the following explanation of the process by which a glow discharge changes to an arc: As the current to the cathode is

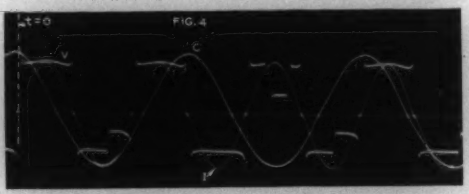

Fig. 4. Current and voltage relations during transition from glow to arc

increased in the glow discharge, a larger portion of current is due to electrons leaving the cathode; these electrons are not emitted uniformly from the cathode surface, but come primarily from small portions of the cathode, which because of some impurity are especially active. These electrons produce ionization in the region of the cathode drop, this ionization being greatest in the vicinity of the active spots. Due to their high mobility, the electrons leave this region much more rapidly than do the positive ions. A high space charge results, increasing the electric field in the vicinity of these active spots as well as the number of electrons emitted therefrom. This process is cumulative and proceeds rapidly until the electric field near one of the spots increases to an amount sufficient to produce electrons from the cathode by the attractive force of the field alone. When this occurs, an arc is formed with its low cathode drop and extremely high current density to the cathode spot.

This explanation is based upon arcs at low pressure; it is probable, however, that the same process is effective at atmospheric pressure, and occurs every time the current in an a-c. arc passes through zero, except when the electrodes are so refractory that they can support a high enough temperature to produce a large electron current by thermionic emission.

Transient Oscillations in Coupled Windings

A mathematical study of the oscillations occurring in a pair of mutually coupled windings, the primary and secondary of a transformer, when one of the terminals is subjected to the impact of a traveling wave, has been completed. The general conclusions reached in this study are summarized in the following article.

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IN THE PAST, the mathematical analysis of transient oscillations in transformer windings has been based upon a single winding having self-inductance and mutual inductance between its turns, capacitances along the stack and to ground, and in one instance, resistances to represent the losses. Such a circuit ignores the presence of secondary circuits, but, strangely enough, proves quite adequate to describe the internal high-frequency transients of the winding under consideration, not only qualitatively, but quantitatively as well.

Cathode ray oscillograms, however, do show some difference in the characteristics of the oscillations, depending upon the terminal connections of the secondary circuits. This is particularly true in the case of an isolated neutral primary winding, where a change from an open-circuited to a short-circuited secondary may bring about considerable changes in the frequencies of oscillations. This shift of frequencies has been attributed loosely to a change in the effective inductance of the circuit, brought about by closing the secondary circuit; just as the natural frequency of a simple lumped inductance-capacitance series circuit is changed if the inductance is reduced by short-circuiting a coupled winding. In addition to the above limitation of the single winding theory of transformer oscillations, there was nothing in the equations relative to the internal oscillations of the secondary circuit.

The complete idealized circuit of a two-winding transformer is shown in Fig. 1. The primary winding, on which the traveling wave is assumed to impinge, is designated as winding 1, and all associated voltages and currents have the corresponding subscript as e_1, i_{s1}, i_{x1}, and i_{L1}. The secondary winding is

Based upon "Transient Oscillations of Mutually Coupled Windings" (No. 32-4) presented at the A.I.E.E. winter convention, New York, N. Y., Jan. 25-29, 1932.

designated as winding 2. The terminals are shown connected to impedances Z_1, Z_2, Z_3, and the incoming surge impedance Z. Each winding has capacitance C and K to ground and along the stack, respectively, and an effective self-inductance L. The two windings are coupled magnetically by an effective mutual inductance M, and electrostatically by capacitance C_3. It is pertinent to remark at this point that the effective inductances of the circuit include the partial interlinkages, on certain assumptions, and are not simple, uniformly distributed constants. The necessity for these more complicated assumptions is responsible for greatly increasing the complexity of the problem.

The application of Kirchhoff's laws to the elements of the circuit shown in Fig. 1, permits the partial differential equations of the circuit to be written. A solution then is found such that the terminal and boundary conditions are satisfied.

The initial distribution caused by the impact of an abrupt wave front depends only upon the capacitance elements of the circuit, because the currents through the capacitive paths are infinite for an infinite rate of change of voltage, whereas the currents in the inductive paths are all zero at that first instant. Thus the circuit which is effective for calculating the initial distribution may be simplified by eliminating the inductances shown on Fig. 1.

The idealized circuit of Fig. 1 is free of losses, and therefore stabilization does not occur (theoretically) unless the terminal impedances have losses. For zero or infinite values of the terminal impedances the oscillations never do subside, but persist forever. However, any actual circuit possesses some losses, and consequently the oscillations eventually die out and the currents reach permanent values, so that there is no change of flux and there are no induced voltages. The distribution of voltage in the primary winding is then uniform, ignoring the conductance from the winding to ground, and the potential of the secondary is constant throughout the winding. Thus while the realization of these final distributions is contingent upon the presence of losses, either in the circuit itself or in the terminal impedances, nevertheless there are fixed axes of oscillation about which the transient oscillation of the no-loss circuit take place.

The complete solutions have not been attempted, except for zero and infinite values of the terminal impedance; that is, for grounded and isolated terminals. The solutions which have been worked out are also restricted to rectangular, applied waves. The response to waves of arbitrary shape can always be found in the usual way by an application of Duhamel's theorem, as described in a previous paper, "Transient Oscillations in Distributed Circuits," by L. V. Bewley, A.I.E.E. Trans., v. 50, 1931, p. 1215–33. The solutions are in the form

e = (final distribution) + Σ (harmonic space and time oscillations).

The time harmonics are always *cosine* functions, and since Duhamel's theorem is operative only on the *time* functions of the solution, the response to different arbitrary wave shapes may be written down by inspection from the corresponding solutions given in the previous paper, where the time functions were also harmonic *cosine* oscillations.

Conclusions and Findings

As far as a description of the transient in the primary winding is concerned, both qualitatively and quantitatively, it is not necessary to consider the influence of the secondary winding beyond keeping in mind that its terminal conditions will change the relative importance of the natural frequencies of oscillation. But these changes in frequency can be accounted for quite adequately by changing the effective inductance in the equations.

The transient in the two-winding circuit consists of an infinite series of space and time harmonics, oscillating about the final distribution as an axis of oscillation. The amplitudes of these harmonic oscillations depend upon the initial and final distributions, and are in fact given by the Fourier analysis of the difference between them.

The space harmonics which appear in the solution are decided by the Fourier series chosen to represent the initial distribution throughout the length of the winding. The fundamental wavelength upon which the Fourier analysis is made is dictated by convenience in any specific case, and is therefore more or less arbitrary. Thus for certain terminal conditions, a full range *cosine* series may prove the most appropriate, while in another case a half range *sine* series may lead to the greatest simplification.

To each space harmonic there correspond two distinct time harmonics; that is, each space harmonic consists of two components vibrating at widely different rates. The amplitudes of these two time

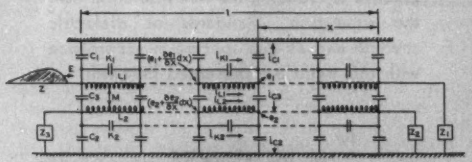

Fig. 1. Complete idealized circuit of a two-winding transformer subjected to high frequency transients caused by an incoming wave

C_1 = capacitance of primary winding to ground
C_2 = capacitance of secondary winding to ground
C_3 = capacitance between primary and secondary windings
K_1 = capacitance between ends of primary
K_2 = capacitance between ends of secondary
L_1 = effective self-inductance of primary
L_2 = effective self-inductance of secondary
M = effective mutual inductance between windings
Z = surge impedance of line at primary
$Z_1(p)$ = grounding impedance of primary neutral
$Z_2(p)$ = terminal impedance of secondary, neutral end
$Z_3(p)$ = terminal impedance of secondary, line end
E = terminal voltage of primary due to traveling wave
p = $\partial/\partial t$ = partial time derivative
t = time
i_{c1} i_{k1} i_{L1} i_{c3} i_{k2} i_{L2} i_{c2} = currents through C_1 K_1 etc.
e_1, e_2 = instantaneous voltages at any point x of primary and secondary, respectively
x = fraction of total winding from neutral end
l = 1 = total length of winding.

harmonics are usually quite different, but by a change of terminal conditions, it is possible to change their relative importance.

The harmonic frequencies of the secondary circuit are the same as those of the primary winding, but the amplitudes bear a ratio to the corresponding amplitudes in the primary which depends upon the order of the space harmonic. In other words, there is no fixed proportionality between the oscillations in the two circuits.

The oscillations corresponding to an infinite rectangular applied waves start simultaneously throughout the windings, and the time harmonics are all *cosine* functions. The response to applied waves of arbitrary shape can be obtained by an application of Duhamel's theorem.

Coordination of Line and Transformer Insulation

The coordination of transformer insulation with line insulation recently has been discussed widely, and sentiment has changed gradually in favor of the use of an air-gap for purposes of coordination as against the practise of reducing the line insulation near the substation. Standards of dielectric strength and air-gap spacing in accordance with this trend are presented herewith.

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AT THE Toronto convention of the Institute in June 1930, a paper "Recommendations on Balancing Transformer and Line Insulations on Basis of Impulse Voltage Strength," by V. M. Montsinger and W. M. Dann, A.I.E.E. TRANS., v. 49, 1930, p. 1478–81, sponsored by the transformer subcommittee of the electrical machinery committee, was presented to bring before the membership the status of certain work done by the subcommittee in connection with the coordination of transformer and line insulation.

Two things of interest and importance were included in this paper: first, a recommended practise of expressing the impulse strength of a transformer in terms of the 60-cycle dry flashover of suspension insulators; and second, recommendations for coordinating the impulse strengths of the transformer and the line insulation. These recommendations included either the use of a safety gap of known flashover characteristics connected in parallel with the transformer, or the reduction of the line insulation to a coordinating value for a distance of half a mile from the transformer, or a combination of either with a suitable lightning arrester.

Since the publication of this paper the principle of coordination has been discussed widely and it appears to have become accepted in a general way throughout the industry. It seems, however, that there has been a gradual change in sentiment in favor of the use of an air-gap for purposes of coordination, as against the practise of reducing the line insulation. Several reasons have contributed to this shift of sentiment. For example, the idea of having a flashover occur out on the line, even though restricted to a distance of half a mile, seems to be unacceptable to operating engineers, and opinion seems to favor having the flashover occur at an accessible point near the transformer. Any degree of line over-insulation made desirable by local conditions in the vicinity of the station becomes feasible if the coordinating gap is used. Furthermore, a string of insulator disks if used for coordinating purposes affords less chance for a reasonable adjustment of coordinating values. The removal of one disk, for example, from a string of eight, causes a change of approximately $12\frac{1}{2}$ per cent in the impulse flashover value. The difficulties of adjustment naturally are even more pronounced with shorter strings. In contrast with these difficulties, air-gaps may easily be set for any desired degree of adjustment.

The transformer subcommittee has recognized the growing sentiment in favor of a gap for coordinating purposes, and it is the purpose of this brief progress report to bring to the attention of the Institute membership the following revisions which have been made in the previous recommendations.

IMPULSE STRENGTH OF TRANSFORMERS

The yard stick used to express the impulse strength of a transformer has been changed from the 60-cycle flashover value of a given line insulator to a coordinating gap with a given length in inches, as outlined in the following paragraphs:

(*a*) *Transformers Receiving Standard Tests as Specified in Par. 13-400, A.I.E.E. Standards No. 13.* Apparatus conforming with the standards of dielectric strength should be so designed that its impulse strength against lightning is greater than the impulse flashover voltage to earth of an air-gap whose spacing is in accordance with Table I. This spacing is between the ends of two square-cornered, square-cut, co-axial rods not more than $\frac{1}{2}$ in. thick and so mounted that the rod overhangs its support at least one-half the gap spacing. The insulators used as supports should meet the N.E.M.A.-N.E.L.A. 60-cycle flashover requirements for the line voltage.

(*b*) *Transformers Receiving Other Than Standard Test.* For trans-

Full text of "The Coordination of Transformer Insulation With Line Insulation" (No. 32-64) which is to be presented at the A.I.E.E. summer convention, Cleveland, Ohio, June 20-24, 1932, and is sponsored by the transformer subcommittee of the electrical machinery committee: V. M. Montsinger, *chairman*, W. H. Cooney, W. M. Dann, H. C. Louis, Basil Lanphier, L. C. Nichols, George Vaughan, F. J. Vogel.

formers receiving a test different from that given for the rated circuit voltage in (*a*) the gap spacing should correspond to the test which the transformer will receive, in accordance with the relation between test and gap spacing given in (*a*).

Recommendations Eliminated

The "Recommendations for Coordinating Transformer Insulation with Line Insulation in the Field," included in Part II of the Montsinger-Dann paper of June 1930, will be eliminated from the recommendations of the subcommittee. These recommendations involve the three methods of coordinating transformers with line insulation referred to in the opening paragraphs of this report. The coordinating gap replaces the eliminated recommendations and serves the following purposes:

1. It establishes the standard of impulse strength required in the design of a transformer.
2. In practise, it limits the magnitude of incoming surge voltages to values less than the impulse strength of the transformer, thereby establishing coordination.
3. A lightning arrester may be used in conjunction with the coordinating gap to prevent system outages.

Table I—Air-Gap Spacings

Rated Circuit Voltage	Transformer 60-Cycle Test Voltage	Spacing of Air-gap
Kv.	Kv., r.m.s.	Inches
13.8	28.6	4.25
23	47	6.25
34.5	69	9.25
46	93	12.25
69	139	18.75
92	185	25.00
115	231	31.5
138	277	38.25
161	323	44.5
196	393	54.5
230	461	64.0

Development of the Waukegan Station

The reasons for the development, choice of site, and general plan of the Waukegan station are outlined briefly in this article. The three major periods of development are covered, the article serving as an introduction to the two companion articles "Waukegan Features New Electrical Design" and "A 115,000-Kw. Turbo-Alternator," which follow.

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THE WAUKEGAN station of the Public Service Company of Northern Illinois is located approximately 40 miles north of Chicago at the extreme northeast limits of the city of Waukegan on the west shore of Lake Michigan. This station, with an installed capacity of 290,000 kw., performs the dual function of supplying energy to a metropolitan system and to a surrounding transmission system.

Based upon "Development of the Waukegan Station of the Public Service Company of Northern Illinois" (No. 32M9) presented at the A.I.E.E. Great Lakes District meeting, Milwaukee, Wis., March 14–16, 1932.

During the year 1916, in giving consideration to load development and corresponding facilities for generating capacity to take care of this load, it became increasingly evident that the future demands for electricity in the Chicago metropolitan district would require substantially larger power station developments than had been considered heretofore. It was evident also that it would be necessary to locate such developments on Lake Michigan where an unlimited supply of condensing water was available.

As a result of these conclusions, a careful survey was made of all suitable power station sites, bearing in mind those fundamental requirements of adequate water supply, transportation facilities, expansion space, rights-of-way for disposing of energy generated, and proper correlation with respect to the load area to be served. This survey revealed that the power station sites most suitable for development to supply the Chicago metropolitan district were at Waukegan on the north, and at the Illinois-Indiana state line on the south. In the intervening distance of 50 miles along Lake Michigan no other suitable sites were adequate or available.

On the southern site the initial development of the commonly known State Line station of the Chicago District Electric Generating Corporation has taken place. The northern, Waukegan, site was acquired in 1917. The original site comprised 87.6 acres with 1,223 ft. of shore line on Lake Michigan. This has been increased since to a total of 198 acres and 3,249 ft. of shore line The site could be served from two good coal-bearing railroads with a possibility of harbor development, and was suitably located for the acquisition of private rights-of-way to dispose of the large volume of energy it was proposed to produce. A private right-of-way 250 ft. wide was acquired. This connects with its three branches consisting of a 135 ft. southerly right-of-way to Chicago, a 150 ft. northerly right-of-way

to Milwaukee, and a 150 ft. westerly and southerly right-of-way which surrounds the Chicago metropolitan area.

At the time the site was acquired, it was thought that the first transmission lines for carrying bulk energy would be at 66 kv. and possibly a 132-kv. development could be expected later. It was fortunate that by the time the initial station development took place it was practical to proceed with 132-kv. transmission with its corresponding increase in capacity.

Initial Development Period

Ground was broken for the initial development of the station on August 23, 1922, and the first unit of 25,000 kw. capacity was placed in service October 11, 1923. Unit 2, for 35,000 kw., was placed in service April 6, 1925. Both units 1 and 2 operate at 350-lb. pressure with a total temperature of 675 deg. fahr. with no reheat. Three boilers serve each unit. These boilers are equipped with chain grate stokers, and it is of interest to note that this was the first successful application of alternating current to variable speed individual stoker drive, the speed variation being approximately 40 per cent with a flexibility about equal to that obtainable with d-c. motors. Generation is at 12 volts, kv., the switching equipment consisting of the conventional cell type construction with a Cory system of interlocks.

At this period of the development it was thought that the ultimate capacity of the station would be of the order of 200,000 or 300,000 kw.

Second Development Period

Unit 3, of 50,000-kw. capacity, went into service June 22, 1927. The operating steam pressure was raised to 600 lb. with a total temperature of 725 deg. fahr. A radical change in the type of electrical equipment was made with the installation of this unit, this change being the first complete installation in this country of metal-clad switching equipment for power station service.

For years electrical engineers of this country had considered metal-clad equipment but believed its development unsuited to American capacities and conditions despite the fact that it had been used extensively and successfully in England for many years. Naturally enough, the first installation carried with it some grief. However, the experience gained suggested future improvements and demonstrated the practicability of this type of switching equipment with its many inherent advantages over the conventional open type installation.

The continued results obtained with the metal-clad switchgear on unit 3 were so universally satisfactory from engineering construction and operating considerations that the exclusive use of this type of gear was adopted as a policy for all future power station and substation installations or additions.

A few of the outstanding advantages of metal-clad switchgear are:

1. Hazards to personnel are eliminated almost completely.
2. The carrying on of construction work is simplified and expedited.
3. Almost complete salvage value is obtained when the growth of the system compels replacement.
4. Costs are no more when all factors, including building structures switch cells, and bus compartments, are taken into consideration.

Unit 4, of 65,000-kw. capacity, was placed in service May 10, 1930. The use of pulverized fuel was decided upon prior to the installation of this unit. A thorough investigation was made of existing installations and a decision was reached to adopt the unit system with ball and table type mills. The operating steam pressure and temperature is the same as for unit 3 with the exception that an important change in the steam cycle was instituted. Steam is bled from the turbine at approximately 200-lb. pressure from the thirty-second row of buckets and reheated to a total temperature of 725 deg. fahr. One of the three boilers supplying the unit is of the reheat type. Generation continued at 12 kv. similar to the three previous units and, continuing the policy referred to above, metal-clad switchgear was used as on unit 3. Following is a tabulation of station performance for units 3 and 4 for the month of July 1931, using southern Illinois coal with a moisture content of approximately 13 per cent:

B.t.u. per lb. of coal	11,469
B.t.u. per kw-hr. output	13,299
Lb. of coal per kw-hr. output	1.16
Monthly load factor (per cent)	44.1

Third Development Period

Unit 5 of 115,000-kw. capacity went into service September 1, 1931. With the installation of this unit an important departure was made in the switching arrangements. The generator bus was eliminated and the generator, together with its 120,000-kva. transformer bank stepping up to 132 kv., were considered as a unit, all switching being done at 132 kv. Again in accordance with the policy previously referred to, metal-clad switchgear was used. The use of this equipment on the 132-kv. installation marks the first of its kind in the world.

A further investigation of pulverized fuel mills led to the use of the tube type unit mills on unit 5. While this type of mill requires more power than the ball and table type mill, particularly during light load operation, it was thought that the maintenance problem would be simplified. These mills have not been in operation long enough to determine definitely characteristics of flexibility of operation or to make a general comparison with the ball and table type mill. Each of the three boilers supplying this unit is served by three mills with a capacity of 25,000 lb. of coal per hr., respectively. The steam cycle is similar to unit 4, steam being bled from the thirty-first row of buckets for reheat to 750 deg. fahr. One of the three boilers on unit 5 is equipped for reheat.

With the addition of unit 5 bringing the station capacity up to 290,000 kw., it was considered advisable to supplement the coal handling system with a rotary car dumper. This installation is unique in that the complete system, including the mule haul which pushes the loaded cars up an incline to the dumper, was developed for a-c. operation.

Application of a-c. motors to individual variable speed stoker drive and to coal handling equipment came about as a result of a policy adopted in 1906. It was felt that in order to stimulate the development of a-c. flexibility it would be advisable for the company to insist upon the use of a-c. equipment and to share with the manufacturer the grief and expense certain to be encountered in such a development. The experience derived from each case, while somewhat unpleasant at the time of development, has resulted in the complete and successful adaptation of a-c. drive to the various pieces of equipment considered. This in turn has been decidedly helpful to the power sales organization.

Future Development

The present station capacity of 290,000 kw. covers what was thought to be the complete development at the time the first unit was installed in 1923. A definite prediction at this time as to the ultimate development of the Waukegan station would be to place one in the tenuous position of all prophets. However, it would appear far safer to predict a figure of 1,000,000 kw. than 500,000 kw. Bearing this in mind, it was necessary to give serious consideration to transmission facilities for future station output. The earlier 132-kv. circuits to Chicago were designed for approximately 90,000-kva. capacity and consisted of 300,000-cir. mil conductors. The latest circuit installed in 1930 consisted of 750,000-cir. mil conductors with a carrying capacity of approximately 180,000 kva.

A station which in its development over a 10-year period finds its last installed unit practically five times the size of its first unit, certainly offers a challenge to the engineer—a challenge to coordinate the successive developments so as not to nullify any preceding investment and at the same time to take advantage of the developments in the art to obtain an efficient workable station as a whole. Waukegan station, it is felt, meets these requirements.

Waukegan Features *New* Electrical Designs

Three new electrical developments incorporated during the last development period of Waukegan station are described in this article. They include the first 132-kv. metal-clad switchgear ever used, a 115,000-kw. single-shaft turbo-alternator the rotor of which was the largest forging ever made in this country, and a coal-car mule for which a new scheme of a-c. drive was developed.

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THE THIRD and most recent development period at the Waukegan station of the Public Service Company of Northern Illinois includes two outstanding features: namely, the first 132-kv. metal-clad switchgear ever used, and a 115-kw. single-shaft turbo-alternator.

Based upon "Electrical Design Features of Waukegan Station" (No. 32-57) presented at the A.I.E.E. Great Lakes District meeting, Milwaukee, Wis., March 14-16, 1932.

During the previous development periods, described in the preceding article "Development of the Waukegan Station," an open type steel structure for 132-kv. switching had been installed which included a number of rather unusual features, due partly to the fact that it was necessary to conserve space in one direction, whereas there was ample space in the other direction. As the main bus is located above the other equipment in the middle of the structure, it appears that there are three buses. However, the line and transformer buses are connected so that they form a rectangular ring bus with the main bus in the middle. The line and transformer reserve buses may be sectionalized by means of an oil switch of load-break disconnecting switches.

132-Kv. Metal-Clad Switchgear

The 132-kv. metal-clad switchgear consists of two double-bus units installed as shown in Fig. 1. One of these units is for switching the high voltage side of the 120,000-kva. transformer bank supplied by generator 5, and the other is for a 132-kv. transmission line. The buses of these two units are connected to, and form an extension of, the main and reserve buses in the open type steel structure. These two double-bus switchgear units are arranged as indicated in Fig. 2, and consist of oil filled cable buses and interconnections, special motor driven disconnecting switches enclosed in metal housings, oil switches equipped with potheads instead of outdoor bushings, and special bus connections and disconnecting devices for the instrument transformers.

The switchgear is rated to carry 1,200 amperes and the oil circuit breakers will interrupt 2,500,000 kva. at rated voltage. The capacity of the buses may be increased to 2,400 amperes by installing another set of buses. The present buses consist

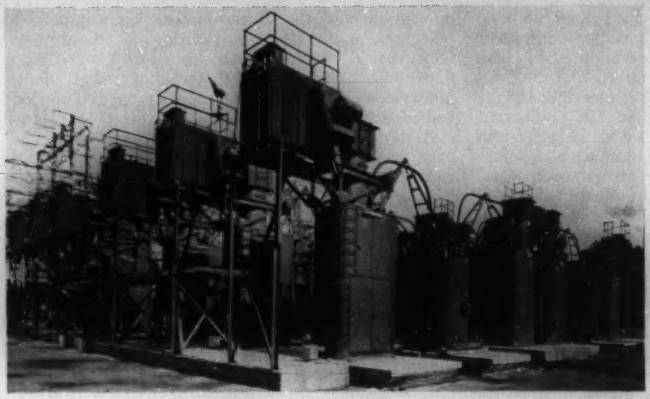


Fig. 1. The 132-kv. metal-clad switchgear, part of unit 5 installation, is the first ever used

of 3,020,000-cir. mil, oil-filled, paper-insulated, lead-covered, copper-armored cable. Isolated racks support the bus cable about 9 ft. above the switchgear foundations as it loops from switchgear unit to switchgear unit. The ends of each of these bus cable loops are insulated, and the midpoint of each cable sheath in each loop is grounded to keep the induced voltage in the cable sheath at a minimum.

The disconnecting switch consists of contacts in an oil filled tank equipped with entrance bushings which in turn are enclosed in an outer housing. The tank as well as the bushing on the bus side is raised and lowered by a motor driven mechanism, and overtravel is prevented by limit switches. When the tank is lowered, the circuit is opened under oil and the bus contact on the entrance bushing withdraws from its bus receptacle, thus providing a visual separation which through a sight glass may be observed from the outside of the housing. The bus receptacle consists of a hollow porcelain shell that forms a part of the main structure into which the entrance bushing on the disconnecting switch tank enters. The opening in the lower end of this porcelain shell is automatically covered by a metal cover when the disconnecting switch is withdrawn. These switches are operated in groups from the oil circuit breaker control panel, or individually at the disconnecting unit.

As it is seldom necessary to disconnect a potential transformer, this disconnecting device is not motor operated. A portable motor, however, has been provided for raising or lowering the potential transformer "coupler" tank whenever necessary.

A number of interlocks is provided to prevent operating errors and to protect personnel. For instance, one of the interlocks prevents the opening of the upper door in the disconnecting switch house until the disconnecting switch is opened; this causes the shutter which prevents access to live parts to close. Another interlock prevents operation of any or all disconnecting switches on both sides of the circuit breaker unless the latter is open. This interlock is effective on each disconnecting switch on individual operation as well as on group control. The circuit breaker cannot be closed unless all the disconnecting switches on both sides of the breaker are fully open or completely closed. An interlock also prevents operating any of the line disconnecting switches unless the line cable test switches are open. Conversely, no line cable test switch can be operated until line disconnecting switches have been opened. An interlock also prevents the lowering of any potential transformer coupler tank unless the ground switch and test switch on that phase are closed. An interlock also prevents opening any ground switch or test switch until the potential transformer coupler tank is in the connected position; this is accomplished by means of a system of Cory locks.

115,000-Kw. Generator

The generator which is tied into the 132-kv. metal-clad switchgear equipment is a 115,000-kw. single-shaft unit, designated as unit 5. A description of its mechanical details is included in the companion article, "A 115,000-Kw. Turbo-Alternator," which follows. This unit generates at 18,000 volts and with its 120,000-kva. transformer bank constitutes an operating unit without an intervening bus. The generator leads are tapped to supply the 10,000-kva. auxiliary power transformer, and the high voltage and low voltage switchgear units provided for this transformer are tripped by differential relays in case internal trouble develops, so that interference with the generator operation is avoided.

Auxiliary System

The low voltage side of this 10,000-kva. auxiliary power transformer is connected to the main 2,400-volt station auxiliary bus which can be sectionalized by units, or can be operated as one bus. Reactors are provided between sections of this bus for fault current control. Power for starting the auxiliaries on units 3, 4, or 5, or for emergency operation in case one of the station auxiliary transformers is out of service, is obtained from the auxiliary bus.

The capacity of the auxiliary power transformers

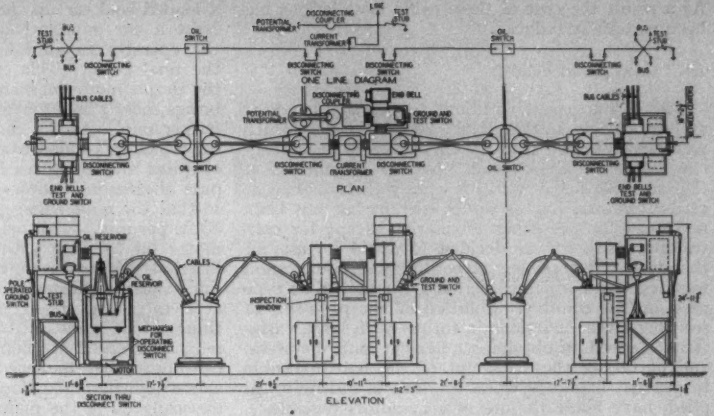


Fig. 2. Layout of one phase of the 132-kv. metal-clad switchgear

in the present installation is 9.4 per cent of the generator capacity, the active and reserve transformer capacity being 7.4 per cent and 2 per cent, respectively. These are selected so as to give under normal demand conditions 20 to 30 per cent unused capacity in each transformer.

Generator Field Control

Instead of using generator field rheostat and a common excitation bus, as was provided for the first four units, a main and a pilot exciter have been provided on the shaft of unit 5. On this unit the generator voltage is controlled by means of the main exciter field rheostat, thus resulting in a considerable saving due to the elimination of generator field rheostat losses. In addition, a much more rapid and flexible method of controlling the generator is provided, and in case automatic voltage control is later considered advisable, it can be provided easily at a comparatively small additional cost.

Although the use of a common excitation bus as installed for the first four units provides reserve capacity, it was felt that the expense of reserve excitation was not justified for unit 5 because the latter must be shut down in order to repair either exciter, and because, in addition to the reliability of present-day exciters, the main exciter will operate self-excited, thus making it possible to operate without the pilot exciter.

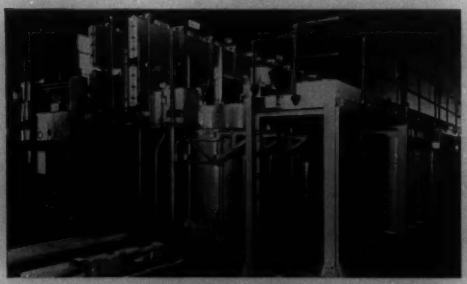


Fig. 3. The 12-kv. metal-clad switchgear used in the second development period

Generator Cables and Potheads

On the unit 5 installation four single-conductor, 3,000,000-cir. mil, paper-core, 25-kv., paper-insulated, lead-covered cables are used for each phase. These cables extend from the generator to the 120,000-kva. transformer bank in fiber ducts. This 16-duct bank was designed in the form of a square surrounding a large square tile placed in the center of the duct bank to permit air circulation, thus equalizing the internal and external temperatures of the ducts.

Special care in design was used to make the cables carry equal load currents and to avoid injurious sheath voltages. The cable phases in the ducts have been so arranged that the electromagnetic fields surrounding the cables tend to neutralize each other, thus equalizing reactances and avoiding reductions in carrying capacity.

As it was considered more economical to have induced voltages on the cable sheaths than to suffer the losses due to induced sheath currents, cable-sheath insulators were placed at the ends and at about the midpoint of the 550-ft. fiber duct run, thus dividing the cable sheaths into two sections. These two cable-sheath sections are grounded at their midpoints, thus making the induced sheath voltage too small to affect the lead cable sheaths injuriously. Oil filled potheads as well as oil filled joints have been used on the cables for unit 5, as an added safety feature which should insure maximum reliability in service.

On the small power cable the very expensive conduit runs which were needed to protect cable of the ordinary type from mechanical injury have been eliminated and instead, armored cables laid in troughs suspended from the ceiling are used.

As a result the cost of these cable installations has been materially reduced.

A-C. Car-Mule Drive

One of the recent additions to the coal-handling system at this station is the coal-car mule, which pushes the loaded cars up an incline to the rotary car dumper. The special service requirements of the car-mule drive would normally dictate the use of d-c. motors, but as direct current has not been necessary for the other auxiliaries except for control purposes, it was decided to avoid its use for this device, if possible. Accordingly an a-c. system was developed which is, perhaps, the first of its type used in this country. Solution of the problems of securing large variations in torque with large variations in speed, of obtaining a flexible control system, and of taking the slack out of the hoisting cable to prevent breakage when the load is suddenly applied, have made the use of a-c. motors possible.

The essential feature of this installation is the use of a slow, two-speed, 440-volt, high-torque motor. Coupled directly to the torque motor is the 500-hp., 2,300-volt, wound-rotor, main driving motor. The drive shaft to which the motors are coupled is geared to the car-mule cable hoisting and lowering drum.

The control system of the equipment which pushes a loaded coal car up the incline is complex, but to hoist a car automatically it is only necessary for the operator to move a master control switch to the final point. This closes contactors which put the torque motor on its high speed winding and thus brings the car mule out of the pit at a speed of 150 ft. per min. As the car mule approaches the coal car which has rolled over the hump, a limit switch operates and energizes intermediate circuits which puts the torque motor on its low-speed winding, so that the mule engages the coal car at a speed of 50 ft. per min. This operation also places the main motor on the line with all its starting resistance inserted. After the car has been picked up, another limit switch operates to energize a contactor which accelerates the main motor. This process continues in six steps until the main motor reaches its maximum speed of about 300 ft. per min. As the car approaches the car dumper cradle, the car is slowed down to 150 ft. per min. by inserting automatically all of the main motor resistance, and the torque motor is put on its high-speed winding. If the cradle is properly seated, the car and mule will proceed to the final mule limit; at this point the motors stop automatically and the brakes set. By reversal of the master switch, other motors change the position of the track gates through which the car mule leaves or enters the pit, and the car mule is lowered automatically.

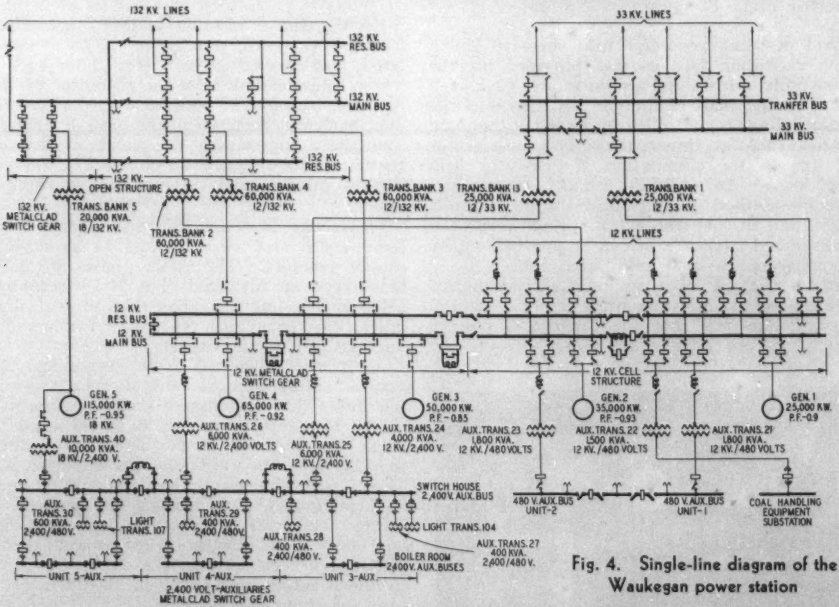

132 KV. LINES
132 KV. RES. BUS
132 KV. MAIN BUS
132 KV. RES. BUS
132 KV. OPEN STRUCTURE
132 KV. METALCLAD SWITCH GEAR
TRANS. BANK 5 20,000 KVA. 18/132 KV.
TRANS. BANK 2 60,000 KVA. 12/132 KV.
TRANS. BANK 4 60,000 KVA. 12/132 KV.
TRANS. BANK 3 60,000 KVA. 12/132 KV.
TRANS. BANK 13 25,000 KVA. 12/33 KV.
33 KV. LINES
33 KV. TRANFER BUS
33 KV. MAIN BUS
TRANS. BANK 1 25,000 KVA. 12/33 KV.
12 KV. LINES
12 KV. RES. BUS
12 KV. MAIN BUS
12 KV. METALCLAD SWITCH GEAR
12 KV. CELL STRUCTURE
GEN. 5 115,000 KW. P.F.-0.95 18 KV.
GEN. 4 65,000 KW. P.F.-0.92
GEN. 3 50,000 KW. P.F.-0.85
GEN. 2 35,000 KW. P.F.-0.93
GEN. 1 25,000 KW. P.F.-0.9
AUX. TRANS. 40 10,000 KVA. 18 KV./2,400 V.
AUX. TRANS. 26 6,000 KVA. 12 KV./2,400 VOLTS
AUX. TRANS. 25 6,000 KVA. 12 KV./2,400 V.
AUX. TRANS. 24 4,000 KVA. 12 KV./2,400 V.
AUX. TRANS. 23 1,800 KVA. 12 KV./480 VOLTS
AUX. TRANS. 22 1,500 KVA. 12 KV./480 VOLTS
AUX. TRANS. 21 1,800 KVA. 12 KV./480 VOLTS
SWITCH HOUSE 2,400 V. AUX. BUS
480 V. AUX. BUS UNIT-2
480 V. AUX. BUS UNIT-1
COAL HANDLING EQUIPMENT SUBSTATION
AUX. TRANS. 30 500 KVA. 2,400/480 V.
LIGHT TRANS. 107
AUX. TRANS. 29 400 KVA. 2,400/480 V.
AUX. TRANS. 28 400 KVA. 2,400/480 V.
LIGHT TRANS. 104
AUX. TRANS. 27 400 KVA. 2,400/480 V.
BOILER ROOM 2,400 V. AUX. BUSES
UNIT 5-AUX.
UNIT 4-AUX.
UNIT 3-AUX.
2,400 VOLT-AUXILIARIES METALCLAD SWITCH GEAR

Fig. 4. Single-line diagram of the Waukegan power station

Development of the station is illustrated by this diagram, the generating units having been installed in the order 1 to 5. The later auxiliary bus is 2,400 volts with metal-clad switchgear instead of the earlier 480-volt open type bus with connections extending from the oil switches up to the disconnecting switches and then to the overhead bus. Instead of the 12-kv. cell type structure used with the earlier units, later units have 12-kv. metal-clad switchgear with one circuit breaker and two selector switches to connect with both main and reserve buses. In the most recent installation, generator 5, the generator and its transformers are operated as a unit, the switchgear being the 132-kv. metal-clad type

A 115,000-Kw. Turbo-Alternator

The tendency of large steam turbine design toward single-shaft units has greatly increased the size of generators operating at 1,800 r.p.m. Consequently, the designer has had to solve a number of problems, mechanical and electrical, because of the great axial length of these machines and the large weights involved, particularly in the rotor. A new scheme of rotor ventilation and other features of such an alternator are described in this article.

By
R. B. WILLIAMSON
FELLOW A.I.E.E.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

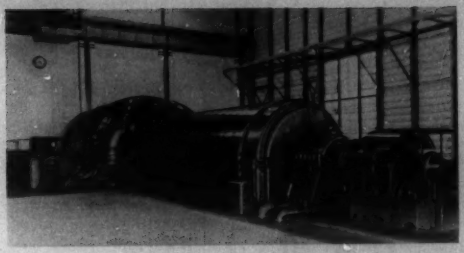


Fig. 1. The 115,000-kw. single-shaft unit installed in the Waukegan station

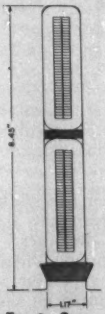


Fig. 2. Stator slot section

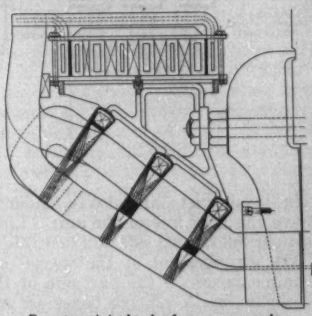


Fig. 3. Method of supporting the projecting ends of the stator coils

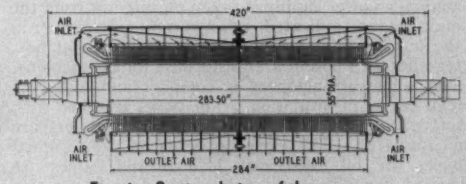


Fig. 4. Sectional view of the generator

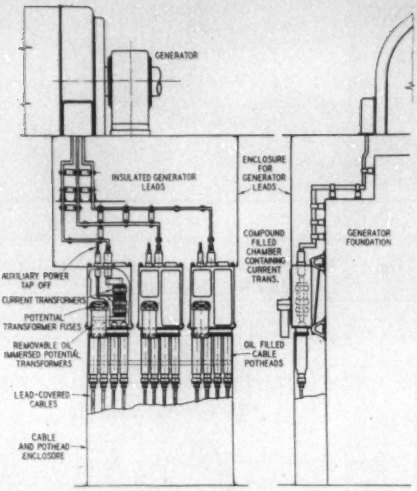
IN SEPTEMBER 1931 a 115,000-kw., 0.95-power factor, 121,000-kva., 1,800-r.p.m. generator was put into operation in the Waukegan station of the Public Service Company of Northern Illinois. The station is described in two preceding articles, "Development of the Waukegan Station" and "Waukegan Features New Electrical Designs."

This generator is wound for 18,000 volts, 3,884 amperes, three-phase, 60 cycles. The voltage for this generator was decided after careful study, both from the operating point of view and from considerations of generator design. The whole output of the machine, with the exception of a small part used for the operation of station auxiliaries, is stepped up and all switching done on the high voltage side of the transformers; hence the voltage of this unit did not have to correspond with that of the older units in the station, and it was possible to wind the generator for 18,000 volts in order to obtain the best type of stator winding. The stator winding is placed in 84 open slots, 21 per pole, and connected in two parallel circuits. Two conductors per slot give the simplest form of winding and eliminate practically all danger of insulation breakdown between turns. The coils are made in halves, each conductor being built up of asbestos-covered, varnish-treated strands transposed to eliminate stray currents. At each end of the stator the half coils are connected together with solid clips to form one-turn coils. Since the winding is in two parallel circuits, each conductor carries one-half of the total current output.

The coils are insulated with mica tape, with asphaltum base binder. The insulation is molded in place in such a manner as to secure a dense insulation free from air inclusions. A layer of asbestos tape treated with varnish is placed on the outside of the coils to form a corona sheath. The whole winding was subjected to the standard A.I.E.E. test of 37,000 volts for one minute and there was very little evidence of corona at this voltage. The stator slot and arrangement of conductors are shown in Fig. 2. The projecting ends of the coils, Fig. 3, are supported by lashing to insulated non-magnetic brackets which form ring supports and at the same time avoid closed circuits for stray currents induced by leakage fluxes. In Fig. 4 is shown a sectional view of the generator.

The terminals of the winding are brought out at each side of the end housing so as not to interfere

Based upon "115,000-Kw. Turbo-Alternator" (No. 32-58) presented at the A.I.E.E. Great Lakes District meeting, Milwaukee, Wis., March 14-16, 1932.



with the air ducts, and also to render them accessible above the floor line of the unit. Line terminals are brought out on one side and neutrals on the other.

The arrangement of the special compound-filled terminal boxes on the line side of the generator is shown in Fig. 5. These boxes are mounted on the foundation wall directly below the outlet on the generator. Each of the leads is provided with a terminal box in which current transformers for differential protection are mounted. A tap for auxiliary power supply is taken off directly from the main leads as indicated, and a current transformer in the auxiliary tap is provided in the terminal box, together with potential transformers for the machine. The whole arrangement is compact and affords a high degree of insulation. The boxes are filled with soft compound and the potential transformers are oil insulated. The cable potheads on the terminal boxes are oil filled, and lead-covered cables are carried down the side wall of the foundation and protected by a casing extending to the basement floor. This casing is made of aluminum plates bolted together so as to be readily removable.

The stator frame is of welded construction and made in two sections for convenience in handling, the halves being bolted together in a plane normal to the shaft at the center of the machine. An end view of the stator core and yoke with the stator laminations in place is shown in Fig. 6, while Fig. 7 shows the completed winding. The axial length of the laminated core is 281 in. (714 cm.) between end heads. The punchings are clamped between heavy finger plates of non-magnetic cast steel. In stacking the core, the laminations were pressed down by means of hydraulic jacks, as the work progressed. The core punchings are of silicon steel having a loss not to exceed 0.75 watt per lb. at a density of 10,000 c.g.s. lines per sq. cm., 60 cycles. The stator end enclosures are of non-magnetic cast iron. The stator with core and windings complete weighs 350,800 lb. net (159,000 kg.) and was shipped on a special car designed for 400,000 lb. (181,000 kg.) load.

Rotor Construction

The construction of the rotor for such a large high speed machine required a great deal of study as the weight of the finished rotor is 228,650 lb. (103,600 kg.). The weight of the rough turned forging was 240,000 lb. (109,000 kg.) and, before rough turning, 264,000 lb. (119,500 kg.). The forging was made from an ingot 108 in. (274 cm.) diameter, weighing approximately 480,000 lb. (218,000 kg.). The finished diameter of the rotor body is 55 in. (139.6 cm.) and the peripheral speed 26,000 ft. per min. (132 m. per sec.). There was considerable discussion with the steel makers as to the possibility of securing a sound forging of such large size and weight in a single piece. Several alternatives were considered, and it was finally decided to make the forging in one piece, but to arrange the design so that if difficulties were encountered the stub shafts could be cut off and stubs bolted to the body, thus making a three-piece construction. Fortunately this was not necessary, as the steel maker produced a single-piece forging which after careful physical tests and inspection by boring proved satisfactory in every respect.

Fig. 5. (Left) Terminal boxes for stator leads

Fig. 6. (Right) Stator with laminations in place

The material in the rotor forging is open-hearth carbon steel, with a small percentage of vanadium thoroughly annealed. The body is approximately 24 ft. (732 cm.) long and the distance between bearing centers 420 in. (1,070 cm.). The rotor body after slotting, also one of the coil retaining rings, is shown in Fig. 8. The rotor is bored throughout its length with an 8-in. (20.3-cm.) hole, the surface of which is polished. The stub shafts are given a smooth finish, the same as on the bearing journals, to remove all tool marks and avoid localized stresses that might start cracks during long continued service. For the same reason all fillets on the rotor and end rings are carefully polished. The rotor end rings are of high tensile strength, non-magnetic, alloy steel in order to reduce stray loss.

In general, the rotor construction does not differ materially from that used for similar large rotors. All insulation is of mica and asbestos. On account of the large diameter of the stub shafts it was not advisable to mount the collector rings between the outboard bearing and the generator, as the rings would have to be of such large diameter that the rubbing speed at the brushes would be too high. The rings were therefore mounted outside the bearings, and leads brought through the shaft.

A new method of ventilation was used on this rotor because on account of its great axial length, the methods heretofore used would not be effective in ventilating the central part. The usual method of rotor ventilation has been to provide longitudinal channels under the coils, into which air can be drawn from each end of the rotor. Holes drilled down through the teeth connect with these channels and when the machine is in operation, air is drawn in from each end through the channels under the rotor coils and thrown out of the holes by centrifugal action. This method works well for rotors of medium length, but for very long machines it is difficult to secure enough inlet duct area under the coils to supply adequate ventilation; and what ventilation is obtained is not uniform along the length of the rotor body.

In the present case, instead of using the centrifugal effect and feeding air in at the bottom of the slots from each end, a method was devised for taking up air out of the air-gap at the circumference of the rotor and utilizing the impact head to force air down through the ventilating holes, returning it to the air-gap. Air from separate ventilating fans is supplied under pressure to the air chambers at each end of the stator and from there passes into 14 inlets (Figs. 3 and 4) spaced equally around the back of the stator punchings From these chambers it blows inward in a radial direction against the rotor, makes a U-turn and passes out radially through the yoke. Thus, air is blown in against the rotor at 14 points and this air is comparatively cool, as it has traveled only a short distance from the inlet. A small portion of the air is by-passed back of the coils in order to cool the part of the stator core behind the teeth, but the greater part blows in against the rotor. There is thus a strong circulation of air through the air-gap at all points throughout the length of the rotor.

The scrubbing action of the surface and the ventilation at the ends of the rotor removes a large part of the heat, but it is also necessary to provide additional ventilation as stated above. The method used in this case is shown in Fig. 9. Radial inlet holes are drilled to within a short distance of the roots of the teeth and outlet holes are drilled at an angle as shown, so as to connect with the former at the bottom. Plugs cut away on the under side are screwed into the tops of the inlet holes as indicated and a short channel is cut in the tooth lip as shown to connect with the slot in the under side of the plug. The plugs are of course locked in position so as to prevent any possibility of turning. When the rotor is rotating, at a peripheral speed in this case of 26,000 ft. per min. (132 m. per sec.), the impact head is sufficient to force air through inlet and outlet holes. Numerous tests made on models showed that the air velocity through the ventilating holes is at least 6,000 to 8,000 ft. per min. (30.5 to 40.7 m. per sec.). Also tests made with an experimental rotor, with and without these ventilating holes but otherwise under exactly similar conditions, showed a decided gain in cooling effect with the ventilating holes. The ventilation does not depend on any centrifugal action, as the centrifugal effects on the air in the inlet and outlet holes are balanced. With this arrangement, as the length of the rotor is increased, the number of ventilating units and the air carrying capacity are also increased in proportion, and a long rotor can be ventilated as effectively as a short one. It might be thought that this method of rotor ventilation would be noisy, but such has not proved to be the case as the rotor makes no more

Fig. 7. Stator with completed winding

Fig. 8. Rotor core and shaft after slotting, also one of the coil retaining rings (left)

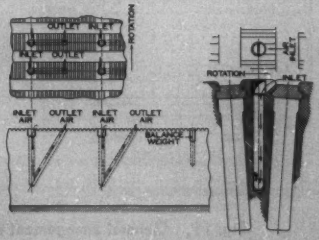


Fig. 9. Method of securing rotor ventilation (right)

noise than one provided with the usual centrifugal ventilation.

Air Supply

Air is supplied to the generator by four separate motor driven blowers mounted within the foundation space, directly beneath the generator and operating on a closed system. Two of the blowers as installed are shown in Fig. 10, the other two being similarly located on the opposite side of the foundation.

Separate fans were used for several reasons. With a rotor of such large weight and length of body, it was necessary to keep the stub shafts as short as possible and the use of self-contained fans with their air inlets adds considerably to the length of the shaft. Moreover, the large shaft restricts the air inlets to such an extent that self-contained fans could not deliver the amount of air required without excessive inlet velocities and consequent loss in efficiency. Separate fans are more efficient and permit better mechanical design of the rotor, besides being more quiet in operation. Each fan can deliver 50,000 cu. ft. (1,420 cu. m.) of air per min. against 9-in. (22.8-cm.) static pressure. The fans operate at 1,160 r.p.m. and each requires a maximum of 104 hp. To allow ample margin, 150-hp. line-start, squirrel-cage motors are provided. The fans are single inlet type with runners mounted directly on a shaft extension of the motor. All four fan inlets open directly into the chamber under the coolers into which the air is discharged. With the generator delivering 70,000 to 80,000 kw. it is found that two fans furnish sufficient air, and four are operated only under full load conditions. Outlet dampers are provided on each fan so that it can be cut off when not in use. Fig. 11 shows the general arrangement of the blowers in relation to the generator and air coolers.

For cooling the air, condensate is circulated through a fin type radiator cooler mounted directly under the generator. The cooler is designed to handle 200,000 cu. ft. (5,670 cu. m.) of air per min. with a pressure drop not exceeding $1^1/_2$ in. (3.81 cm.) water. With cooling water temperature not exceeding 80 deg. fahr. (26.6 deg. cent.), it will absorb 6,985,000 B.t.u. per hour and deliver air to the generator inlets at a temperature not exceeding 104 deg. fahr. (40 deg. cent.).

Excitation and Alternator Characteristics

The rotor is wound for 250-volt excitation and current is supplied by a 350-kw. shunt wound exciter coupled to the turbo-alternator. The main exciter is a two-bearing machine with bearings lubricated from the oil circulating system of the main unit. A pilot exciter of 7.5-kw. output is overhung on the main exciter. This 250-volt machine provides excitation for the fields of the main exciter.

As shown by shop tests, the excitation required to secure rated terminal voltage at no load is approximately 400 amperes, and that required to secure full load current on short circuit is approximately 600 amperes. Regular operation on the station load indicates that the temperature rise of the generator at full load is well within the guarantees of a 60-deg. cent. rise by detector on the stator, and an 85-deg. cent. rise by resistance on the rotor. The estimated efficiency of the generator at rated load, including power required to drive the separate fans, is 98.1 per cent.

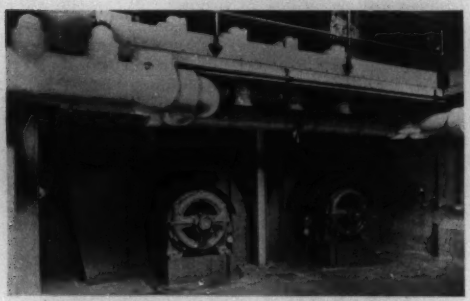


Fig. 10. Two of the four motor driven blowers

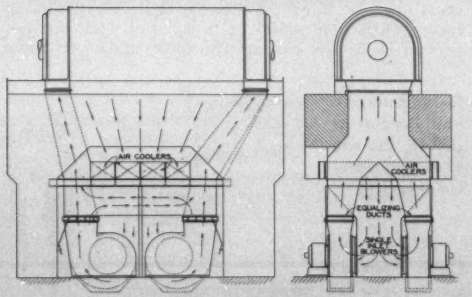


Fig. 11. General arrangement of blowers

An "Exponential" Slide Rule

An "EXPONENTIAL" slide rule has been developed to facilitate problems involving the logarithms or antilogarithms of numbers. It differs from the ordinary slide rule of logarithms in two fundamental respects: (1) natural logarithms (to the base $e = 2.71828$) are given, and (2) both the characteristic and mantissa are determined directly in one reading. Logarithms of numbers from 0.00001 to 100,000, and the corresponding antilogarithms are given. As the addition of the characteristic normally would reduce the accuracy of the rule, the scale of logarithms has been split up into five 10-in. sections, thus giving an accuracy comparable with that of the

ordinary rule. This exponential slide rule was developed by L. B. Sklar (A '30) 816 North 6th Street, Philadelphia, Pa.

Mr. Sklar states that for determining the logarithms of numbers less than unity, he has discovered a method which may be used both with his new rule and with the ordinary polyphase slide rule. This method involves the use of the *CI* scale in conjunction with the *L* scale, instead of the customary use of the *D* scale with the *L* scale. In dealing with logarithms of numbers less than unity, this method saves time and simplifies the steps involved with a resulting decrease in the possibility of error.

To find, for example, the value of $0.0003^{1.47}$ place the runner of the ordinary slide rule at 3 on the *CI* scale and read the mantissa -0.523 on the *L* scale. The characteristic for numbers less than unity always is equal to the number of zeros, and therefore in this case is -3; the logarithm thus is -3.523. Multiplying this by 1.47 gives -5.18, and the antilogarithm of this number must next be found. Placing the slider at 18 on the *L* scale gives 662 on the *CI* scale. The characteristic -5 indicates that there are five zeros following the decimal point, and the answer is therefore 0.00000662.

It may be seen that if this problem had been solved by the use of the *D* scale, as is customary, rather than the *CI* scale, it would have been necessary to add the step of making the usual subtraction before the correct logarithm is given. A similar subtraction would have been necessary in finding the antilogarithm, and to avoid error pencil-and-paper operations would have been necessary in performing these subtractions. The use of the *CI* scale instead of the *D* scale automatically eliminates the necessity of any subtraction in finding the logarithms of numbers less than unity.

Motors for 3,000-Volt Multiple Unit Cars

A new multiple unit car motor incorporating many novel design features was developed for the electrification of the Lackawanna suburban service in New Jersey. So far, these motors have required but little maintenance, and have been remarkably free from flashovers, insulation failures, and mechanical troubles.

By
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MEMBER A.I.E.E.

General Electric Co., Erie, Pa.

ABSENCE OF TROUBLE in commencing service and in maintaining it has characterized the entire suburban electrification program of the Delaware, Lackawanna and Western Railroad. This is especially significant in view of the fact that it is the first multiple unit suburban service in this country employing a d-c. trolley potential of 3,000 volts. A notable lack of motor trouble is one of the factors responsible for the small number of maintenance difficulties experienced.

There are now in service on the Lackawanna railroad, 564 of these motors, the last 141 of which were placed in service on January 25, 1931, when the extension of the electrification to Dover was completed. By June 1, 1932, 13,000,000 car-miles had been operated, with only two train delays, one of nineteen minutes and one of four minutes, chargeable to motor failure. In view of this splendid operating record, it might be interesting to review briefly some of the motor design features that have contributed toward operating reliability.

Characteristics of the motor are shown by the curves of Fig. 1. The motor has a continuous rating of 97 amperes at 1,500 volts, with field shunt at 50 per cent, and a temperature rise not exceeding 105 deg. cent. above ambient. It has a one-hour rating of 130 amperes with a corresponding temperature rise not exceeding 120 deg. cent. above ambient.

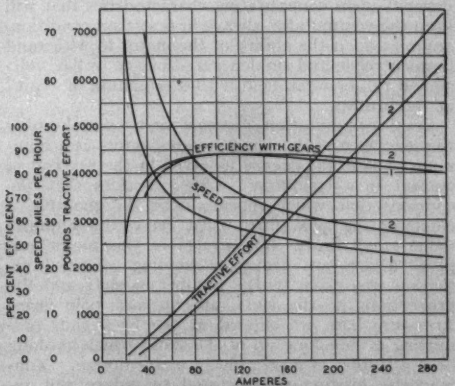

Fig. 1. Characteristic curves for Lackawanna multiple unit car motors at two different field strengths

1—Full field strength
2—Reduced field strength

Based upon "Motors for 3,000-Volt D-C. Multiple Unit Cars" (No. 32-36) presented at the A.I.E.E. winter convention, New York, N. Y., Jan. 25-29, 1932; subsequently brought up to date by the author.

Motor Flashovers Minimized

So far, the motors have been remarkably free from flashovers, insulation failures, and mechanical troubles. Minimizing of motor flashing is an achievement embracing many features of design. Flashing may be caused by interruptions or disturbances in the voltage applied to the motors; also many things within the motor itself may contribute to flashing, some of these being poor commutator condition, commutator roughness, oil and dirt between commutator bars, flat spots, bouncing brushes, and low motor stability.

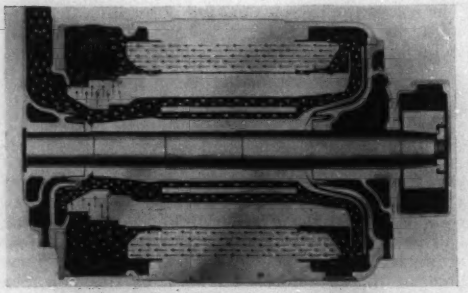

Fig. 2. Cross-section of motor for 3,000-volt d-c. multiple unit cars showing ventilation system

Successful operation of this motor demonstrates the feasibility of a relatively high commutator bar potential. With 281 commutator segments and 1,500 volts applied to the motor terminals, this amounts to 21.3 volts per bar, which is higher than previously used in any 3,000-volt railway motor. Successful operation under these conditions, however, depends upon commutating characteristics that will keep the commutator always in first class condition, and also upon the ability of the motor to withstand frequent wide and sudden variations of trolley voltage on full or weak field with a minimum of "spit" at the brushes.

Good commutation depends first upon keeping the reactance of the armature conductors at a minimum so that the energy involved in the reversal of current in a conductor is low. Besides this, the compensation, which depends upon the quantity of commutating pole flux, must have the required value at all loads. The design of this motor employs a one-turn armature winding. Careful attention was given to the number of slots and the proportions of the slots, air-gap and pole faces. Armature bars are clipped at the back thus permitting a "breaking up of the slots" which has long been a feature of good railway motor design. Nonmagnetic binding wire is used to reduce slot reactance.

It is well known that good commutation usually can be obtained at some one motor load depending upon the adjustment of the commutating field strength; common practise has been to adjust compensation for minimum sparking at some load near the one-hour rating. If the commutating poles were somewhat saturated at this point, the motor would be over-compensated for all lighter loads. To avoid this condition the design of this motor includes ample commutating pole cross-section; as a result, commutation is good from the lightest load to four times the continuous rating. Light loads are mentioned particularly because no sacrifice of commutation at light loads has been made to obtain correct compensation at heavy loads.

To an unusual degree this motor has ability to withstand flashover from voltage interruption. This may be attributed largely to the use of highly responsive commutating poles. Extra turns are wound on the commutating coils; under steady-load conditions the extra magnetomotive force thus produced is consumed in non-magnetic shims at the back of the commutating pole pieces. Thus the commutating pole flux follows very quickly any change in the armature current and tends to maintain correct compensation even under extreme transient conditions. A strong exciting field winding adds to the stability of the motor. The use of an inductive shunt rather than field tapping to obtain weak fields gives any motor a greater ability to withstand flashover from interruption during reduced field operation. In the Lackawanna motor the inductance of the field shunt has been so proportioned that the ability of the motor to withstand flashover on reduced field is superior even to its performance on full field.

Ventilation System Keeps Motors Clean

Motor flashing that might be caused by dirt is avoided by the ventilating scheme developed for this motor. No external blowers are used, but with the system of ventilation adopted the motor operates at all times with its interior either at or slightly above atmospheric pressure. The motors are self-ventilated as shown in Fig. 2. Cooperation of the car builder permitted the ventilating air to be taken from settling chambers over the vestibules to which it is admitted through louvers at each corner of the car roof. A separate duct to each motor extends down through the side and along under the floor of the car to a point over the commutator end bearing where a flexible air connection made of cloth sewed over a coiled wire leads the air to the motor inlet in the commutator end framehead. The flow of air is maintained by a fan on the motor shaft. Air enters the motor under the commutator and passes first through the ducts in the armature; it is then returned by the fan through the field structure of the motor and exhausted at the commutator end. The air outlet opening is covered with an expanded metal screen and a hood, so that foreign material cannot fall or be thrown into the motor.

This method maintains pressure inside all the exposed surfaces of a self-ventilated motor, which means that track dirt, fine snow, or brakeshoe dust cannot enter. It should be noted also that before the ventilating air reaches the commutator chamber

of the motor it is filtered, so to speak, through both the armature and the field coils. Furthermore, any carbon dust originating in the commutator chamber is carried directly to the exhaust openings and does not enter any other parts of the motor. Routine inspections have shown these motors to be unusually clean. Surplus oil from the bearings is led through ducts to the outside of the motor and none finds its way inside.

Commutator Design

Smooth commutators depend not only upon good commutating characteristics but also upon good mechanical design and construction. The use of four brushholders and the low armature current resulting from the high voltage employed permit the commutator to be compact and strong. The commutator has a diameter of $16^1/_4$ in. and a brush surface $2^3/_4$ in. wide. With the cars operating at 70 miles per hr. at least once during every round trip, the motor speed reaches 1,800 r.p.m. At this speed the peripheral velocity at the commutator surface is 7,620 ft. per min.

When the motors were first put into service some brush breakage occurred at high speeds. In a short time, however, the commutators became seasoned so that brush breakage was practically eliminated. The brushholders also play their part in maintaining good commutating conditions. Pressure fingers are of the steel clock-spring type, having low inertia and maintaining their tension permanently; they are centrally located by recessed adjusting sleeves clamped by the first turn of the springs. A non-resilient brush is used to maintain contact with the commutator at high speed. As no abrasive action is necessary to keep the commutator smooth, the brush may be comparatively soft, of low friction coefficient, and may operate with a high contact voltage drop.

Insulation of the motor throughout is in accordance with recognized standards for 3,000-volt railway motors. While the absence of insulation failures in the motors thus far covers a comparatively short period, experience has shown that the same kind of insulation in other 3,000-volt motors lasts indefinitely, failures seldom occurring from any other cause than mechanical damage.

Ratings

Ratings of the motors when ventilated as in service are as follows:

	Volts	Field strength	Shaft hp.	Amperes	R.p.m.	Temperature rise deg. cent.
Continuous	1,500	50%	181	97.0	1,055	105
One hour	1,500	50%	255	137.0	913	120

Although during the time that it is connected the inductive shunt carries 50 per cent of the current passing through the motor, it has a continuous rating of only 34 amperes. The field shunt is designed with a temperature rise characteristic that, at the r.m.s. current obtained in continuous suburban service, will give a temperature rise approximately equal to the corresponding temperature rise of the traction motor exciting fields. Cold equipments coupled in train with hot equipments will share the load equally.

On short runs the r.m.s. current of the shunt slightly exceeds its rating, reaching a peak value on runs of approximately 3,000 ft., where the calculated r.m.s. value is approximately 37 amperes. However, under these conditions the r.m.s current of the motor exceeds its continuous rating for 105 deg. cent. rise by resistance. Not only was the present

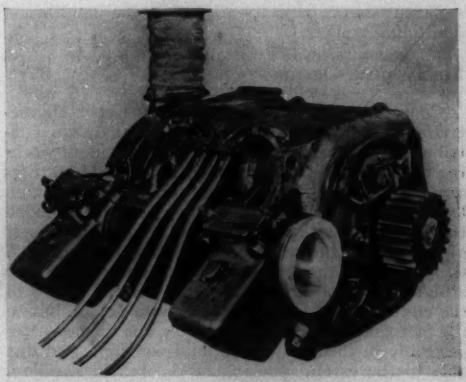

Fig. 3. Complete motor showing pinion and axle bearings. Note "pants-leg" air duct connector at the upper left

electrification of the Lackawanna considered in studying shunt capacity, but also the possibility of extensions into more mountainous territory involving long uphill runs. These studies indicate that these runs do not require a shunt rating of more than one-third the continuous motor rating for 50 per cent field strength operation; this reduction in shunt rating permits a saving in weight.

A view of the complete motor is shown in Fig. 3. Four motors are used on a motor car weighing 81.5 tons loaded; this, together with a trail car weighing 56.5 tons, forms a two-car unit of 138 tons. The motor weighs complete with gear, gear case, and axle lining, 6,850 lb., giving a weight per horsepower of 26.9 lb. The four motors give a capacity for the two-car units of 7.4 hp. per ton. Trains for use in short run commuter service may be made of 2, 4, 6, 8, 10, or 12 cars, half of which in each case are motor cars. A typical six-car train has a free running speed of 67 miles per hr. on level track (Davis friction) and a maximum permissible speed of 70 miles per hr.

Design of the motors permits the use of as high a

train accelerating rate as desired, limited only by the weight on drivers and the slipping point of the wheels. Normally, an automatic acceleration of 1.5 miles per hr. per sec. is maintained, corresponding to an adhesion of 12.8 per cent. Acceleration tests have shown an equipment to be capable of reaching 30 miles per hr. in 20 sec. and 47 miles per hr. in 60 sec.

In frequent stop service a four-motor equipment is well loaded by a motor car and trailer unit, the motor temperature approaching the permissible limit for class B insulation of asbestos and mica tape. Experience has shown, however, that for railway motors, class B insulation tightly applied, molded, and hot-drawn will have a longer life if the motors are run hot enough to keep them free from moisture. In long run service the motors will have sufficient excess capacity to permit the handling of additional trailers.

Mechanical Design

Conservative interpretation of experience characterizes every feature of the mechanical design contributing to low maintenance. Stresses in all working parts are low. Both armature and axle bearings are of the sleeve type and embody the constant oil level feature permitting oiling periods to be extended to several times the usual period. There is a layer of babbitt on the wearing surfaces of the bore and flanges of all the bearings. The almost complete absence of hot bearings during the initial stages of the electrification was due not only to design, but to the fact that all of the linings were line reamed after assembly in their respective final positions, and due also to the careful packing of the bearings, oiling, and breaking in.

Operation of the gearing on the motors is quiet, promising long life. Gears are of special heat-treated steel, General Electric Company grade F, $2^1/_4$ pitch, with long and short addendum tooth form. To insure correct profile, the gear teeth were ground after treatment. Possibility of the gears giving off ringing notes has been overcome by a non-resonant feature obtained by snapping rings of small cross-section into annular grooves machined in the under side of the rim. These rings have a different period of vibration from that of the gear section, thereby counteracting or destroying the vibrations in the gear. The manner in which the rings are assembled provides an annular pocket for the retention of gear grease; this also has a decided damping effect. After assembly, the rings are welded at the joint to prevent any possibility of their coming loose. Gear cases are of malleable iron with three point support.

During eighteen months of operation the maintenance expense of these motors has been extremely low. The time when commutators will have to be turned down is still in the remote future. Very few motors have been removed from the cars for any purpose. There is every reason to expect continued low maintenance for this first multiple unit suburban electrification employing a d-c. trolley potential of 3,000 volts.

Refrigeration Improves the Health of Millions

By
WILLIAM H. ADAMS Detroit, Mich.

ENGINEERING with its benefits enters our homes daily in many ways. Manufacture of artificial ice and mechanical cooling of space have become commonplaces and constitute a major achievement of engineering and science.

But a short generation ago, people lived principally on salt meats, salted and dried fish, dried grains, and dried fruits, and on foods conserved by the early canning and preserving arts, except for a few weeks or months when fresh fruits and vegetables were available from nearby truck farms. The refrigerator freight car and the modern cold-storage warehouse have changed the eating habits of a large part of our people and have brought to the tables of millions of industrial workers articles of food that but recently were the luxuries of the rich.

Early efforts to cool space and goods by the use of natural ice were but partially successful; low temperatures were difficult to obtain and harder to hold uniform. The modern cold-storage warehouse, with temperatures held at any desired level and with but fractional degrees of change, will keep food products in fresh condition for almost an indefinite period.

The consumer has benefited by the lengthened list of foods available, and the health of our people has been improved by this diversity of diet and by the inclusion of vitamin-bearing fruits and vegetables. Instead of the occasional glutted market and then scarcity, the produce of farm, dairy, orchard, and garden now reaches the consumer in orderly and regulated quantities and with a minimum of loss. Lands remote from population centers but well adapted to the production of perishable crops thus may be used with confidence that refrigerated transportation and cold storage at points of consumption or in transit will result in distribution over an adequate time and with the widest possible market.

Our theaters now are cooled and de-humidified mechanically; trains with interior temperatures held at the comfort line ply between our cities and across the desert; office buildings are becoming available with air-conditioning as an added aid to efficiency and comfort. In the most recent field of domestic mechanical refrigeration, more than three million units were in use at the end of 1930, and it is estimated that an additional million were in service by the end of 1931. Presently, at the touch of a switch, our homes will be cooled in summer as readily as they now are warmed in winter.

Editor's Note: This is the eleventh article in the Engineering Foundation's symposium "Has Man Benefited by Engineering Progress?" Pursuant to the invitation of the Engineering Foundation, the editors will be happy to receive comments, criticisms, or discussions pertaining to this or other articles published in this series.

Abstracts

Of Papers to Be Presented at the Summer Convention

INTERPRETIVE abstracts of all technical papers to be presented at the A.I.E.E. summer convention, June 20–24, 1932, are included herewith, excepting only two papers. One of these is published in full on p. 390–1 of this issue; for the other, manuscript had not been received at the time this issue went to press. Members vitally interested and wishing to obtain pamphlet copies may do so by writing to the A.I.E.E. Order Dept., 33 W. 39th Street, New York, N. Y., stating title, author, and number of paper desired. In response to popular demand and within its space limitations ELECTRICAL ENGINEERING subsequently may publish certain of these papers, or technical articles based upon them.

The Engineering Subjects in the Four-Year College Program of Electrical Engineering

By A. H. Lovell[1]

THE PRACTISING engineer is vitally concerned with education because the young graduates are trained to meet the specifications of his profession, to join its ranks, and to work beside him in the years to come. He should give advice therefore as to the economic and professional content and interrelation of the programs.

The Society for the Promotion of Engineering Education report of the study of engineering education from 1923 to 1929 gave valuable recommendations as to the preparatory and secondary subjects in the curricula. In view of the developments of the past few years and of immediate future demands, it is time to study the technological portion of the curriculum in electrical engineering. Studies show what some 33 representative schools provide in required and elective electrical divisions and the semester hours required in cognate engineering subjects. Consideration, study, and suggestions are requested from the members of the Institute who are engaged in active practise. **(A.I.E.E. paper No. 32-74)**

Educational Aspects of Engineering and Management

By R. E. Doherty[2]

SURVEYS made by sending questionnaires to organized groups of engineers have established some important facts regarding functional distribution and financial reward. These facts have been interpreted differently, but in order to use them as the basis of any formulation of educational policy, they should be rationalized in terms of their historical setting. Such has been the object of this study. The three predominant facts from these surveys are:

1. More engineering graduates have ultimately gone into primarily administrative positions than have remained in pure technical engineering activity.
2. The former have received greater financial reward than the latter.
3. Excepting a few recent graduates, the former have learned practically all they have known regarding administration after they left college.

The present study indicates that it would be unwise to adopt either the policy of training college students primarily for management or allowing the technical engineering course itself to be sufficient. Both phases of training are necessary and an attempt should be made to emphasize the phase best suited for each individual.

Definite proposals are outlined regarding the type of college training for the professional groups; and an appeal is made that industry recognize the powerful influence which its past salary policy toward technical engineering leadership, as it is unquestionably reflected in these surveys, will have in turning talented minds away from technical engineering. The appeal is not merely to give such engineering its due, but, in industry's own interest, to prevent the problem in the next generation of having a dried up technical engineering leadership. **(A.I.E.E. paper No. 32-75)**

Chicago District*

By L. L. Perry[3] F. V. Smith[3]

THE LOAD characteristics, generating stations, and transmission lines of the Chicago territory and particularly the power supply of Chicago proper, are outlined in this paper.

The economics of the scheme of supply are discussed from the points of view of interchange energy agreements, comparative incremental fuel costs of generating stations, incremental losses of transmission lines, load schedules, remote metering and load dispatching, economics of 550-lb. to 650-lb. units, automatic frequency regulation, control of voltage, phase angle, and wattless voltamperes.

The reliability of the system is outlined with respect to the design of generators, switchgear, transmission lines and cables, relay protection, methods of operation, and reserve capacity. From the experience gained in the Chicago territory, conclusions are drawn as to the policies of economy and reliability which have been adopted in operating the system. **(A.I.E.E. paper No. 32-76)**

Philadelphia Electric Company's System*

By J. W. Anderson[4] Herbert Estrada[4]

MAXIMUM system economy is attained when the sum of operating costs plus fixed charges on investment is a minimum. Considerations of reliability usually lead to increased capital investment for sturdier facilities and for spare equipment, and consequently add to the fixed charge burden. Fortunately, however, operating costs are to some extent inversely proportional to fixed charges, and analyses of system performance often will reveal

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2. Yale University, New Haven, Conn.

* Part of a symposium on "Combined Aspects of Reliability and Economy in the Operation of Large Electric Systems."

3. American Telephone & Telegraph Company, New York, N. Y.
4. Philadelphia Electric Company, Philadelphia, Pa.
5. Detroit Edison Company, Detroit, Mich.
6. Edison Electric Illuminating Company of Boston, Mass.
7. Sargent & Lundy, Inc., Chicago, Ill.

operating savings which can result from judicious use of investment in spare facilities.

Practises followed on the Philadelphia Electric Company system are discussed in this paper from the standpoint of production facilities in attaining highest system economy consistent with a high degree of service reliability. As the system comprises steam and electric stations of different efficiencies, a large hydroelectric plant, and a major high voltage interconnection, the problems of operating economy are both highly important and complex in character.

The reliability of production facilities of this system is indicated by an analysis of the factors affecting customers' service. In 1931 no interruptions to customer service were caused by the failure of production facilities. Further, the operating economies obtained have resulted in a steady reduction of fuel rate per kw-hr. **(A.I.E.E. paper No. 32-73)**

The Detroit Edison Company's System*

By A. P. Fugill[8]

WITH BUT few exceptions, the requirements for extreme reliability and the economical use of resources in any electric system are diametrically opposed. It is not particularly difficult to design and operate a system to give any practicable degree of reliability of customer service if no consideration need be given to the price the customer must pay. On the other hand, if the service standards were lowered sufficiently, a system could be designed and operated with an over-all economy exceeding present values. The real problem is to obtain the required reliability with the maximum operating economy and the minimum of investment.

Reliability of the service furnished by the Detroit Edison Company is assured: first, by the design and installation of facilities to reduce the probability of outage; and second, by a system layout and operating procedure based on segregation and sectionalization to minimize the effect of any outage. Operating economy is secured: first, by the fundamental design of each new installation for reasonably low production cost; and second, by so allocating the load between generating stations that the more economical machines carry a greater percentage of the total load in so far as the physical location of the load makes this possible. **(A.I.E.E. paper No. 32-70)**

The Edison Electric Illuminating Company of Boston's System*

By R. E. Dillon[8]

IN THE DEVELOPMENT and operation of a successfully managed public utility reliability and economy must be based on the particular conditions inherent to the locality which it serves. As a result, every company's problems must have individual study and no set and fast rules can be established for their solution. However, the policies, practises, and experiences of each are helpful in molding the development of others.

The final plan for the addition of a large block of capacity in generating or distributing facilities is the result of a compromise between those features that seek a minimum of investment outlay, to be obtained by simplicity, and those that urge complications designed to give a high degree of operating flexibility in behalf of reliability. Reliability, it should be pointed out, is not necessarily sacrificed in the plan for less total investment. On some occasions reliability may be assured with smaller total investment by the installation of more spare capacity using simplified equipment at less cost per kw.

On the system of the Edison Electric Illuminating Company of Boston, the occasions of total interruption of service to any large single customer or group of smaller customers due to loss of transmission facilities have been negligible. A decided improvement in operating economy has been secured by generating units, turbines, and boiler equipment. Furthermore, automatic substations together with modern equipment have improved efficiency and reduced labor.

These changes came about in the course of providing for the growth of load. They were attended also with increasing education on the part of the attendants toward efficiency and an increasing vigilance of all forces against losses. **(A.I.E.E. paper No. 32-71)**

Oxid Coatings on Aluminum

By J. D. Edwards[10] Martin Tosterud[10] H. K. Work[10]

INTEREST in oxid coatings on aluminum began with the discovery of the metal about 100 years ago, for the chemical attraction of aluminum for oxygen is one of the most important characteristics of the metal. At various times in the history of aluminum, attention, from the scientific standpoint or from the commercial point of view, has been focused on the oxid film. To the scientist, for example, the electrical characteristics of the oxid film have been of great theoretical interest and for many years have been the subject of experimental study and speculation. Important commercial uses of the film in various electrical devices have followed upon the scientific studies.

The remarkable characteristics of the oxid film are discussed in this paper, and a large number of practical uses which can be made of these characteristics are pointed out. A very important characteristic of the film is its impermeability with high protective properties. Also, extensive use of film-coated aluminum has been made in the electrolytic rectifier, and more recently in the electrolytic condenser.

The extensive use of oxid coatings having thicknesses comparable with those of a paint film is a relatively recent development. By a special process films of greater thickness may be formed which have a hardness partaking of the characteristics of corundum and capable of being made of high dielectric strength so that they can be used for purposes of electrical insulation. These thick oxid films also can be colored by absorption of dyes or mineral pigments.

Many commercial uses other than those of the electrical industry may be made of the various types of oxid film. **(A.I.E.E. paper No. 32-78)**

Calculation of Inductance and Current Distribution in Low Voltage Connections to Electric Furnaces

By C. C. Levy[8]

LOW VOLTAGE circuits supplying electric furnaces present special problems in the calculation of inductance and current distribution, in that the conductors employed vary in arrangement and cross-section, and are relatively short. The very large currents carried give rise to reactive drops of greater magnitude than is usually supposed, and a detailed study of the inductance of such circuits therefore is desirable.

Formulas and methods are presented in this paper for the determination of the inductance of relatively short bars with the particular arrangements found in furnace circuits. Fundamental theorems for deriving geometrical mean distances first are established, leading to the well-known formulas for self-inductance and mutual inductance of circular and rectangular sections. Practical applications of these formulas to the problem of calculating the approximate reactive drop in single phase and three phase furnace circuits are worked up in great detail. The same calculations may be used to determine the approximate operating power factor of the furnace. Unequal current distribution in multiple conductors, due to proximity and skin effects, is shown by numerical applications.

The methods presented while not precise are sufficiently accurate for practical purposes and enable the avoiding of unnecessary reactance. **(A.I.E.E. paper No. 32-79)**

Electrical Equipment for Precipitation Service

By H. Speight[8] V. G. Rydberg[9]

APPLICATION of a strong electrostatic field accompanied by corona discharge to the cleaning of gases was first shown by Hohlfeld in 1824. In 1884 his observations were extended by Sir Oliver Lodge, who continued the work and made a practical installation at a lead smelter in Scotland. In 1905 and 1906 this work was extended by Doctor Cottrell; this extension led to the development of the electrical precipitation process for the separation of solids and liquids from gases. This process is now used in a variety of applications.

For best results, uni-directional current is used, with a negative discharge electrode and positive collecting electrode. The electrical equipment generally employed consists of a specially designed transformer, mechanical rectifier, motor-generator, rectifier motor, switchboard, and accessories. There are, however, many disadvantages to the mechanical rectifier, and a tube type of rectifier has been developed to furnish uni-directional current for meeting the unusual load conditions encountered. This has the following advantages: Less space is required, no surges due to rectification will result in the circuit, the wave form supplied will be regular, the voltage will remain constant, no radio interference will result from the rectifying equipment, polarity is automatically controlled, and operation is very quiet.

The control scheme developed for the tube type of rectifier is relatively simple and is self-protective. The rectifier tube is of rugged construction, and for such tubes an operating life of over 4,000 hr. has been secured. Experience with these installations to date has given the important result that a higher recovery per kw. input is obtained than is secured with mechanical rectification. **(A.I.E.E. paper No. 32-77)**

New Applications of Non-Linear Circuits to Relay and Control Problems

By C. G. Suits[11]

CONNECTIONS of reactors and capacitors in series and in parallel permit obtaining voltampere characteristics which are non-linear and which present interesting possibilities when applied to voltage sensitive and current sensitive relays. With the reactor and capacitor connected in series and properly adjusted, there is a value of increasing voltage for which the current suddenly changes to a high value, and another value of decreasing voltage for which the current suddenly decreases. These characteristics assist in obtaining a relay which is sensitive to small changes in voltage. Similarly, a current sensitive relay can be obtained by the parallel connection of reactor and capacitor.

Based on this principle a voltage relay has been developed which employs a solenoid and armature contactor mechanism energized in parallel with the capacitor of a series non-linear circuit. When used on a source of constant frequency this type of resonant relay may be adjusted to a minimum difference between "pick-up" and "release" of $^1/_4$ per cent and, by change in resistance alone, may be adjusted to a maximum difference of 30 per cent referred to the pick-up value. The maximum power requirement is six watts at twelve voltamperes. The frequency error is of the order of 1 per cent in voltage for a 1 per cent change in frequency.

Using a modification of this same principle, a current sensitive relay has been developed also for which the difference between the pick-up and release values may be adjusted between limits of 3 per cent and 15 per cent. As in the case of the voltage relay, the percentage difference between these values and their magnitude are separately adjustable. The total power input at the resonant current of the current relay is of the order of six watts at 6.5 voltamperes. **(A.I.E.E. paper No. 32-85)**

8. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.
9. Westinghouse Lamp Company, Bloomfield, N. J.
10. Aluminum Company of America, New Kensington, Pa.
11. General Electric Company, Schenectady, N. Y.

Insulation Coordination of Distribution Transformers

By E. D. Treanor[13] W. H. Cooney[13]

AS AN ALTERNATIVE to the use of distribution transformers of present levels of dielectric strength with lightning arresters connected either in the customary manner or having the primary lightning arrester ground interconnected with the grounded neutral of the transformer secondary main, a study of the coordination of insulation of distribution transformers has been carried out.

Test results on distribution transformers designed to meet these requirements of coordinated insulation show that by the use of shields for the high voltage winding and thyrite resistors for the low voltage winding, transformers can be made in which the internal insulation will be protected by flashover of the bushings. The level of insulation chosen and the amount of system protection desired by the use of lightning arresters will determine the economic value of such transformers.

Whatever considerations apply to the discharge of impulses into the secondary circuit must be taken into account, with the knowledge that such transformers have a maintained level of strength which will minimize these discharges. As distribution transformers coordinated at the level of line insulation would be prohibitively expensive, a compromise based on sound past practise seems to present a logical improvement. **(A.I.E.E. paper No. 32-80)**

Characteristics of Surge Generators

By P. L. Bellaschi[14]

THE REQUIREMENTS and limitations of surge generators for transformer testing can be summed up as follows:

When the capacity of the transformer is great, the voltage that can be obtained is in the first place largely determined by the capacity of the surge generator.

If a wave is desired without superimposed oscillations, it is necessary to insert resistance within the generator. The front of the surge then depends on the inductance of the generator and the capacity of the transformer. This is a matter inherent with all surge generator test circuits. Thus, in general, waves of very steep front cannot be obtained with large transformers.

Further, the inserted resistance also limits the voltage by an amount dependent on the proportion of this resistance to the load resistance.

For transformers of low inductance, the length of the wave obtained is determined largely by the capacity of the surge generator. This results in a requirement of large generator capacity if very long waves are to be produced.

If the lead between the transformer and generator is appreciably long, other oscillations will be set up which are highly damped but are appreciable at the generator end. These oscillations occur on the front of the wave only, and will be prominent when measurements are taken at the surge generator. **(A.I.E.E. paper No. 32-87)**

The Coordination of Transformer Insulation With Line Insulation

By V. M. Montsinger[12] W. M. Dann[13]

PUBLISHED in full in this issue of ELECTRICAL ENGINEERING, p. 390–1. **(A.I.E.E. paper No. 32-64)**

12. General Electric Company, Pittsfield, Mass.
13. Westinghouse Electric & Mfg. Company, Sharon, Pa.

Characteristics of Load Ratio Control Circuits

By L. F. Blume[13]

THE INFLUENCE of saturation phenomena in series reactors on the circuit performance of load ratio control equipment has been made the subject of the present study. It has been found that unless care is exercised in the design of these reactors, gross distortion may be introduced into the circuit, resulting in obtaining across the reactor voltage peaks which may endanger the insulation, and greatly increase the rupturing duty of the circuit breakers.

Formulas which have been developed show that the proportion of line voltage absorbed by a series reactor subject to magnetic saturation, can be expressed in terms of the reactive constants of which the circuit is composed, and that the voltage is independent of the current or voltage wave form. Curves based upon numerical solutions show that the peak voltage across the reactor may be limited to relatively small values by the following:

1. Designing the reactors for relatively low flux density.
2. Using an air-gap which is at least 1 per cent of the total length of the magnetic circuit.
3. Designing the reactor with a large magnetizing current, so as to avoid excessive voltages when overload currents are flowing.
4. Providing the transformer with a larger number of small percentage steps so that the reactor may be designed for a smaller fraction of circuit voltage. **(A.I.E.E. paper No. 32-81.)**

Single-Phase Short-Circuit Torque of a Synchronous Machine

By C. A. Nickle[11] C. A. Pierce[14] M. L. Henderson[11]

THE ANALYSIS of synchronous machines previously published by Doherty and Nickle is extended in this paper to include the calculation of torque due to single phase short circuits. The torque is expressed as the sum of odd and even harmonic series which are simply related to those previously derived for the armature current. The effect of amortisseur windings also is taken into account. As an illustration of the application of the equations, the short-circuit torque is calculated for a 100,000-kva. generator.

The mathematical analysis and general equations are presented under the following divisions:

1. Short-circuit armature current.
2. Short-circuit torque.
3. Decrement factors.
4. Single-phase and three-phase reactances. **(A.I.E.E. paper No. 32-72)**

Transient Analysis of A-C. Machinery—II

By Yu H. Ku[15]

AN EXTENSION to salient pole machines is made in this paper, based upon the author's "Transient Analysis of A-C. Machinery." All of the cases as calculated in "Three-Phase Short-Circuit, Synchronous Machines—V," by R. E. Doherty and C. A. Nickel, A.I.E.E. TRANS., v. 49, 1930, p. 700–14, are recalculated by an exact analysis. It is stated that this analysis checks quite closely the approximate analysis of Doherty and Nickle.

Results are given also for a fictitious machine having essentially the same constants as the slotted rotor machine studied in the author's earlier paper, but with salient pole features. Thus comparisons are made regarding transient phenomena of salient pole and slotted rotor machines of essentially the same character.

The effect of external resistance is calculated for different values and, using the machine of Doherty and Nickle, the effect of external reactance and capacitance is also predicted. In the case of capacitance, self-excitation or negative damping is found to exist for certain critical values. **(Pamphlet copies not available.)**

14. Worcester Polytechnic Institute, Worcester, Mass.
15. National University of Chekiang, Hangchow, China.

Influence on Commutation of Brush Contact Drop

By L. R. Ludwig[8] R. M. Baker[8]

IN DESIGNING electrical commutating machinery, an attempt is made usually to produce during commutation a linear change of current with time. This, however, is rarely achieved, and the current density therefore usually is not constant across the brush surface, nor is the contact drop constant. The contact drop also will change with time in any small area on the brush surface, and therefore the static curve between voltage and current measured at the brush contact cannot be used.

In this article the theory and mechanical nature of a sliding contact, the dimensions of a contact, and transient brush drop are discussed. Evidence was found that the number of contact points varied from 10 to more than 50, and these data made possible a determination of the size of contact point necessary to account for the voltage drop observed. It was found that the successful brush has a very large number of contact points, and thus has points of small area which will heat and cool with sufficient rapidity so that high transient voltages are avoided. **(A.I.E.E. paper No. 32-66)**

Wire Communication Aids to Air Transportation

By H. H. Nance[8]

HISTORY of air transportation within the past few years indicates that continued growth may be expected, particularly as hazards to flying are mitigated and safety and dependability are recognized by the public. The government is continuing the extension of airways, weather reporting, and other services, and air transport companies are progressing in developing transport business. Fast and reliable communication service has proved the backbone of weather and position reporting, and has been a valuable aid in the handling of traffic.

Teletypewriter circuits used for land service have been found particularly suited to meeting the various requirements involving simultaneous communication with many stations at remote distances. Other wire communication services, such as long distance telephone and commercial telegraph, have aided also, particularly in reaching points not served by teletypewriter circuits. It is expected wire communication service will continue to be used extensively in connection with air transportation, and will be of considerable aid in its future development. **(A.I.E.E. paper No. 32-82)**

Characteristics of Electromagnetic Radiation From Aircraft in Flight

By J. C. Coe[16] T. C. Rives[16]

DURING 75 flights made in the vicinity of Wright Field, Dayton, Ohio, during 1931, data have been collected to determine the intensity of electromagnetic radiation from aircraft in flight.

16. Signal Corps., War Dept., Wright Field, Dayton, Ohio.

The radiation from the airplane was recorded by a field-strength measuring set located in a frame building. Attenuation was found to be a function of altitude and frequency, while absorption is a function of frequency and the time of day. The occurrence of fading is shown to be determined by these factors.

Among the conclusions which may be drawn from these data are that for ground distances of 0.4 mile or less the field strength decreases with altitude; while at 1 mile there is comparatively little change in field strength with altitude; and for ground distances of 4 miles or more the field strength increases with altitude. There was no difference between the night tests and the daylight tests, provided that the same conditions obtained as to power, antenna, frequency, and altitude, except that the distances free from fading were much less by night than by day. The results of various tests in which fading was encountered at distances under 60 miles lead to the conclusion that the absorption undergone by the reflected or refracted ray is independent of the angle or distance traveled by that ray. **(A.I.E.E. paper No. 32-83)**

Vertically Cut Sound Records

By
H. A. Frederick[17]
H. C. Harrison[17]

FUNDAMENTAL advances in recording and reproducing sound have been made recently through the use of vertical undulations on a disk. These vertically cut disk sound records possess important advantages over laterally cut records, and their use has permitted both the recorder and reproducer to be greatly improved. Among the changes made are the use of "cathode sputtering" to render the original wax electrically conducting before being electroplated, instead of the previous process of graphiting the wax; and the replacing of the abrasive record of the past with a non-abrasive final record.

The improvements which result are:

1. Noise has been reduced 25 to 30 db.
2. Volume range has been increased from about 25 to 30 db. to about 50 to 60 db.
3. Upper frequency cut-off has been extended nearly an octave to about 9,000 cycles.
4. The playing time for a 12-in. record may be increased from about 4 min. to at least 15 min.
5. The life of the record has been tremendously increased.
6. A more faithful reproduction has been obtained as a result of flatter frequency characteristics and less linear distortion, so that sounds are more distinct, life-like, and clean cut.

The demonstrated results with these records are enhanced by the use of better microphones and much more powerful amplifiers and loud speakers. **(A.I.E.E. paper No. 32-84)**

Adequate Wiring of Buildings, an Essential for Good Illumination

By
G. H. Stickney[18]
Walter Sturrock[18]

PROGRESS in securing good illumination in buildings has been seriously impeded within a few years by lack of sufficient wiring capacity, much to the disadvantage of owners and managements. This paper reviews the situation from the point of view of illuminating engineering, in the hope of stimulating interest in the problem, thus promoting wider exemplification of practises which will insure a reasonable prospect of lighting circuits adequate to facilitate proper illumination during the life of a structure.

Fairly definite practises have been established for the lighting of small buildings, and fundamental principles have been established for buildings where the lighting requirements may be more severe. A study of standard illumination levels over the past few years indicates the definite trend toward increased illumination, and the expected continuance of this trend will make inadequate the present wiring of many buildings.

Electrical consumption will doubtless be increased by the number of more or less new lighting applications which are going into use. "Built-in" lighting requiring special construction of walls and ceilings of buildings, or simulated by modified forms of luminaires, is spreading rapidly in this country. Lamps are being used which, in addition to the visible light, supply ultra-violet radiation. Also, consideration must be given to the increased load caused by a variety of devices which are supplied from the lighting circuit.

The quantitative elements of wiring also must be considered, and the existing wiring code should be followed. Specifications which have been prepared should be familiar to all consulting engineers, and subjected to criticism by them. Out of this it is to be hoped there may come generally accepted standards of wiring practise. **(A.I.E.E. paper No. 32-86)**

Dynamic Braking of Synchronous Machines

By
C. E. Kilbourne[11]
I. A. Terry[11]

TWO GENERAL electrical methods of quickly stopping synchronous machines are plugging and dynamic braking. Plugging, consisting of reversing the phase rotation of the voltage applied to the armature winding, is subjected to a number of serious objections. Dynamic braking, consisting of short-circuiting the armature through an external resistor and maintaining field excitation, is more desirable and generally will result in quicker stopping.

An analytical treatment of dynamic braking is presented in this paper, and is new to the extent that it treats variable speed short circuits, and presents a method of allowing for saturation. The analysis is carried out both for constant effective excitation, and for variable excitation, and general equations are presented which enable a determination of the time required to stop a synchronous machine.

The agreement of test values with the calculated values is quite good at the point of optimum resistance. This is true of the revolutions to stop as well as of the current-speed and time-speed curves. As the resistance is increased or decreased with respect to the optimum, the agreement is somewhat less satisfactory. **(A.I.E.E. paper No. 32-67)**

Induction Motor Versatility—The Nature of Its Applications

By
E. W. Henderson[19]

TODAY the induction motor bids fair to bring about another revolution of ideas as regards its use and capabilities. Heretofore, particularly in respect to the squirrel cage motor, it has been confined to rather restricted fields of application. Its starting characteristics and the need of special starting devices were against it. Now, limited-starting-current motors such as those employing double cage rotors are overcoming these starting objections. The use of these "across-the-line" motors has encouraged the idea of throwing standard motors directly on the line as well as the use of induction motors for applications demanding frequent starting or reversing. Formerly the squirrel cage motor was looked upon as one to be applied only for constant speed service; today there are many applications where the operating range covers wide variations in speed.

The demand for adjustable speed has been met to some extent by the slipring motor and commutator type of motor. There is, how-

17. Bell Telephone Laboratories, Inc., New York, N. Y.
18. General Electric Company, Nela Park, Cleveland, Ohio.
19. Reliance Electric & Engineering Company, Cleveland, Ohio.

ever, a number of applications of single winding, simple squirrel cage motors, which has been adapted to a great variety of uses. These motors, it is pointed out, may be classified as follows: division I covers the slips of approximately zero to 20 per cent; division II covers slips of from 20 to 70 per cent; and division III covers the range from 70 per cent slip to standstill. In each of these divisions a variety of starting and running characteristics may be secured by proper motor design. Stopping characteristics also are subject to control.

Applications of squirrel cage motors for rapid and oft-repeated reversing or starting duty have been very active lately. For such service the squirrel cage rotor has many advantages over the d-c. armature, due to its lower inertia, and the fact that no vulnerable winding, commutator, brushes, and brush rigging are required. These and other characteristics which may be obtained in the induction motor are constantly widening its field of application. **(A.I.E.E. paper No. 32-93)**

Current Propagation in Electric Railway Propulsion Systems

By John Riordan[9]

TRACKS of electric railways, being continuously in contact with the earth, allow current to leak into the earth, the track current thus varying continuously at various points along the length of the track, unlike the currents in other conductors of the propulsion system. This paper aims to present a systematic treatment of current propagation in the tracks with a view to providing a theoretical foundation for the treatment of engineering problems in which the electrical behavior of the tracks as a part of the current-carrying system is important.

Such questions generally involve the impedances of electrified railway propulsion networks of varying degrees of complication and their mutual impedances with other conducting systems. Typical practical problems are the calculation of regulation and efficiency, of short-circuit current magnitude and distribution, of induced voltages in communication circuits exposed to the electrified network, and of the effects upon such quantities of changes in one or more of the network elements. Although the method of treatment set forth is illustrated by certain practical examples, the scope of the paper does not include any detailed development of procedure for the engineering application of the results. The treatment is restricted to systems in which the tracks and other leaky conductors, such as ground wires, may be represented with sufficient accuracy by a single conductor; but it includes track discontinuities due to impedances connected either in series with the tracks or between track and ground.

There are developed the properties of a basic circuit consisting of a parallel conductor of finite length, such as a trolley, connected at its terminals to the track which is continuous and infinite. The track currents and voltages to ground of this circuit are derived and collected conveniently into a single table. The self-impedance of this circuit and mutual impedances with other similar circuits are given. These impedances may be employed in representing the propulsion system in the railway network diagram. The basic circuit may be employed also in the construction of cumulative induction curves for neighboring communication lines. Track discontinuities may be taken into account by superposition upon the basic circuit of properly chosen currents flowing only in track-earth circuits. **(A.I.E.E. paper No. 32-92)**

A New High Speed Reactance Relay

By A. R. van C. Warrington[21]

MAINTENANCE of stability on modern interconnected high capacity transmission systems is made considerably easier by the use of relays which not only operate extremely rapidly on line faults, especially three phase short circuits, but refrain from operating on the surges of power which often follow the interruption of the fault current. In this paper a new distance relay is described which, it is stated, seems to go further in the direction of meeting these requirements than anything hitherto described.

The new distance relay operates in the order of one cycle, even on low voltage, and employs reactance as a basis of distance measurement, thereby being free from errors due to the variable resistance of the fault itself. The relay is operated by motor units of the dynamometer type and consequently produces many times the torque per unit of electrical input that could be obtained with the induction disk or plunger type of relay.

The distance measurement is carried out by two reactance ohmunits, one set to operate on faults within a zone reaching nearly to the end of the protected line and the other given a higher setting reaching out well into the neighboring section for which back-up protection is desirable. Faults are distinguished from surge and load conditions by a starting unit which is a very sensitive directional relay having a voltage-restraint which gives it an ohmic characteristic. The design employed for the starting unit provides advantages which can be summarized as follows:

1. Maximum protection against undesirable operation during heavy surges of power between generating sources.
2. Maximum response to fault currents, *i. e.*, maximum directional sensitivity only present when required—at low voltage. This is accomplished without the use of contacts and without excessive burden at any potential, normal or below.
3. Extremely rapid action obtained even at low voltages with sturdy relay parts and with normal travels and contact pressures.

The timing unit consists of a clockwork mechanism controlled by an escapement and operated by means of a d-c. solenoid. The function of the timing unit is to allow tripping of the circuit breaker up to a higher ohmic value and after a suitable time delay if the fault is not near enough to warrant instantaneous tripping; also, to trip after a maximum time interval in case of emergency. **(A.I.E.E. paper No. 32-12)**

Operation of Relays From Carrier-Current Coupling Capacitors and Capacitance Transformer Bushings

By J. E. Clem[11] R. E. Cordray[21]

APPLICATION of carrier current communication to transmission lines required the development of coupling capacitors. These coupling capacitors may be used also in combination with transformers to obtain potential from the transmission line. This potential will be suitable for the operation of certain instruments and relays, depending upon burden and accuracy requirements. By the addition of suitable chokes, the coupling capacitors may be used also for carrier current communication. It is the purpose of this paper to describe briefly these coupling capacitors, and to point out means for utilizing them for the purpose of obtaining potential for relaying operation, and to call attention to some applications.

The low voltampere capacity of these potential sources, when it is desired to maintain relatively small phase angle errors, renders them suitable only for supplying relay circuits of low burden. By the use of parallel capacitors, however, the burdens of other relays may be brought within the capacity of these potential sources. Ground directional current relays may be supplied from these sources in certain cases, depending upon the complexity of the relaying for the entire system and the ratio and phase angle errors which may be tolerated. In addition to coupling capacitors, within recent years capacitance transformer bushings have been developed which incorporate a tap for obtaining voltage from the line through the capacitance of the bushings. In general, bushing potential devices are suitable sources for reactance relay potential on voltages of 132 kv. and up, and have been applied successfully at 115 kv. on lines of moderate length. **(Pamphlet copies not available.)**

20. Union Electric Light & Power Company, St. Louis, Mo.
21. General Electric Company, Philadelphia, Pa.

Application of High Speed Relays

By G. W. Gerrell[21]

CONSTRUCTION of the Osage hydroelectric plant and its interconnection with the existing system of the Union Electric Light & Power Company of St. Louis, Mo., made desirable a study of the relaying schemes as applied for the 66-kv. and 132-kv. transmission lines.

Stability investigations and operating experience definitely indicated the desirability of high speed relays and high speed oil circuit breakers. On the existing system it was possible in a number of cases to use the old oil circuit breakers, rebuilding them for high speed operation.

In the selection of relays for phase-to-phase and three-phase faults, it appeared that during parallel line operation balanced percentage differential relays of the high speed type would offer the simplest and most efficient solution. An analysis of the individual circuits, however, showed that the application of this type of relay was rather limited, and distance relays of the impedance directional type or reactance directional type were required on some of the lines. These two latter types also were used for protection against phase-to-phase and three-phase faults on single lines. Time delay overcurrent relays were used throughout for back-up protection.

For protection against line-to-ground faults, balanced ground current relays were installed in the majority of cases for parallel lines, instantaneous directional ground overcurrent relays being required in two cases for parallel lines. For protection against line-to-ground faults on single lines, either time delay or instantaneous ground relays were used, most of them being of the directional type. Special means were developed for determining the calibration of the reactance and impedance relays.

To date the performance of the high speed relays as applied to this system has been questionable. In favor of these relays it may be said that the relays and the associated high speed circuit breakers have cleared a large number of faults rapidly and correctly, while in their disfavor several cases of operating trouble have occurred. These indicate that the present types of high speed directional relays probably are not applicable to certain types of systems. Further analysis indicates that there are fundamental defects in the design of certain types of high speed relays. Modifications of this particular type of relay, however, are being made. **(A.I.E.E. paper No. 32-11)**

The Boric Acid Fuse

By A. P. Strom[8] H. L. Rawlins[8]

RECOGNITION of the part played by gas blasts in interrupting arcs in oil circuit breakers and expulsion fuses has opened new avenues for improvements in these devices. The present paper deals with a new type of fuse in which greatly improved performance is obtained by more effective use of the self-generated gas blast.

In this fuse, a form of construction is used which permits the interruption of the smaller ranges of current within a device that is capable of interrupting also heavy short circuits up to 20,000 amperes or more. A special feature of this design is that the lower ranges of current are transferred automatically to, and interrupted in, a small auxiliary fuse bore. While the construction may be used to advantage with any gas generating material, the present design embodies a compressed boric acid liner which has been found to be much more effective than fiber in extinguishing arcs.

Since boric acid evolves water vapor, a condensable gas, it becomes possible to construct a totally enclosed fuse in which the gas blast is discharged into a surface condenser. With such construction, currents of from 5 to 20,000 amperes at 13,000 volts have been interrupted with an electrode separation of less than six inches, using a relatively small condenser. Currents of more than 20,000 amperes have been interrupted by similar fuses of the open type. This type of fuse readily may be designed for various current and voltage ratings. **(A.I.E.E. paper No. 32-65)**

Relay Operation From Bushing Potential Devices

By P. O. Langguth[8] V. B. Jones[8]

FIELD EXPERIENCE over the last three years establishes the condenser bushing potential device as a reliable and adequate source of potential for the relaying of high voltage systems. The potential device utilizes the inherent potentiometer characteristics of standard condenser bushings used in high voltage circuit breakers and transformers, and depends for its operation on the charging current through the bushing acting as an electrostatic condenser.

Experience shows that potential devices applied within their burden rating will function properly with over-current-directional relays, voltage relays, and distance relays, in various combinations. It is quite possible that the silicon steel device is not sufficiently accurate for some exceptional relays susceptible to phase angle errors, in which cases tests indicate that the hypernik potential device is satisfactory.

Although not so accurate as the potential transformer, the potential device sometimes is more desirable as a source of relay potential. The phase relation between the line voltage and the relay voltage can be easily varied to suit particular system conditions; furthermore, the potential device gives more effective protection with less relay complication than when the potential transformers are connected to the low voltage bus. This being inherently a self-protecting device, no high voltage fuses and switches are required. The successful operation on many large systems, including relaying, indicates definitely the worth of bushing potential devices and the elimination of high voltage potential transformers. The low cost of these devices and the elimination of high voltage potential transformers justify the bushing potential device where usable.

Performance data including curves and oscillograms are given in this paper to illustrate the functioning of directional and impedance relays when energized by potential devices, and typical installations including results of staged field tests are reviewed. **(Pamphlet copies not available.)**

Operating Experience With Supervisory Control on the Reading-Philadelphia Suburban Electrification

By J. E. Pastoret[23]

ALL SUBSTATIONS and switching stations for the Reading suburban electrification are non-attended and are operated by supervisory control. The supervisory control system provides the dispatcher with the following operating features:

1. Control and indication on all circuit breakers and motor operated trolley sectionalizing switches.
2. When an automatic operation occurs, an alarm bell is sounded, proper indication of the position of the unit is given, and a disagreement lamp indicates which unit has operated.
3. An alarm is sounded and an indication is given if any substation battery voltage reaches a predetermined low value; indication is given also when the battery voltage returns to normal.
4. An alarm is sounded and an indication is given if the temperature of any power transformer on the system reaches a predetermined high value; indication is given also when the temperature returns to a safe operating value.
5. All substation bus differential lockout relays are electrically reset by supervisory control.

Supervisory control was selected on the basis of flexibility, speed with which the system can be cleared up at the time of fault, freedom from error, concentration of operation at one point, elimination of divided responsibility, and economy. Two men maintain the equipment which is installed in 21 stations. There has been no trouble experienced from induction, no faulty operations have been performed,

22. New York Edison Company, New York, N. Y.
23. Reading Company, Philadelphia, Pa.

no faulty indications given, and not a single train delay has been caused by failure of the supervisory control equipment. Each benefit attributed to the equipment has been realized fully in operation, proving the adequacy of supervisory control for operating an electrified railway. **(A.I.E.E. paper No. 32-14)**

Developments in Two-Wire Supervisory Systems

By J. H. Oliver[21]

SPECIFICATIONS for a supervisory system have been modified only slightly during the last few years, and usually require the following: reliability, low maintenance, high speed, simplicity, flexibility, minimum connecting wires, and good appearance. The requirement of minimum interconnecting wires especially is important when the control is to be extended any distance.

A general summary of supervisory control schemes using a minimum of connecting wires is as follows:

1. The four-wire synchronous selector system in use for several years is recommended for the control and indication of both large and small stations where four wires are available or can be procured at small expense.

2. The audible selector system is recommended for the control and indication of small switching, pumping, or hydroelectric stations where operation is infrequent and only one pair of open construction wires is available.

3. The two-wire code selector system is recommended for the control and indication of stations having 23 circuits or less where line wires are economically limited to a single pair.

4. The two-wire synchronous selector system is recommended for the control and indication of small or large stations where the distance between the stations is not over fifteen miles and where only two wires are available or where the additional cost (where the wires are rented) prohibits the use of the four-wire synchronous system.

5. The code synchronous system is recommended for control and indication where several stations are located in the same general direction and it is desired to operate the stations over a common set of wires.

6. The audible indication equipment is recommended for small switching stations, pumping stations, etc., where it is desired to obtain a periodic check only on the indication of a maximum of eleven circuit conditions over the telephone company system from any telephone station. **(A.I.E.E. paper No. 32-13)**

Report on Telemetering, Supervisory Control and Associated Communication Circuits

A SUBCOMMITTEE of two committees of the Institute, namely, the committee on automatic stations, D. W. Taylor,[18] *chairman*, and the committee on instruments and measurements, E. J. Rutan,[25] *chairman*, has prepared a report which tabulates and describes, from the point of view of the operating engineer or user, telemetering and supervisory control systems in use today.

The tabulation in the telemetering and supervisory control section of the report enables the prospective user who has a certain requirement in mind, for example, the telemetering of a-c. kilowatts, to determine immediately the systems available for that purpose. All proved systems in general use are tabulated with their characteristics such as accuracy and speed of indication, enabling the engineer to select the system or a few systems particularly adapted for individual conditions. Each scheme has included with it data supplying the characteristics of the communication circuits suitable for the purpose; for example, the user may determine if the scheme he has selected can be used with a given loop resistance with a metallic circuit, but cannot be used with a grounded or non-metallic circuit. A description of the communication circuit is given covering such problems as the use of one circuit for more than one purpose (telemetering and talking, for example) and data on grounding, crosstalk, induction, etc., are given. While much of the information is not new, the tabulation and correlating of the data with the communication circuit is new, and much work has been done by the subcommittee in preparing the data on this phase of the subject.

The Torque Balance Telemeter

By A. J. Johnston[21]

BY MEANS of the torque balance telemeter it is now possible to indicate or record with instrument speed and accuracy, the value of such quantities as watts, amperes, volts, temperature, pressure, and flow. These indications may be made up to distances of 100 miles. The value of direct current which is used as the translating means is well within the limit stipulated by the telephone companies. Also, the telemeter automatically compensates for variation in line wire resistance, auxiliary supply power voltage, and variations in tube characteristics.

The device consists fundamentally of an instrument mirror located on an operating element and deflecting light from a lamp source through suitable lenses and mirrors onto two photoelectric tubes of the gas-filled type. The latter tubes are connected to the grid potential of a pliotron tube which supplies the current to be transmitted to the receiving end of the telemetering system.

The receiver may be any form of indicating or recording d-c. milliammeter. If desired, two or more receivers may be operated in series by one transmitter. Likewise, when it is desired to totalize the values of two or more quantities, the transmitters may be connected in parallel to a single receiver. **(A.I.E.E. paper No. 32-88)**

Application and Performance of Automatic Equipment on the American Gas and Electric System

By Philip Sporn[24] Basil Lanphier[24] H. E. Turner[24]

DESCRIPTIONS of the great variety of applications of automatic equipment throughout the system of the American Gas and Electric Company are contained in this paper. Reasons for the installations are given, and operating experiences are presented.

The history of the development in operation of automatic station equipment on this system leads to the following conclusions:

1. The flexibility and adaptability of the automatic station when properly applied can contribute greatly to improvement of service.

2. The reliability of automatic equipment is at least as good as that of the very best type of operator, and in general is better than that of the average operator, provided the equipment is maintained reasonably.

3. The automatic station is the ideal solution for handling operating problems at all isolated and lonely locations.

4. Properly applied automatic stations will not only improve service but will do so at a reduced cost.

5. Automatic practise is not only adaptable to its usual functions on power systems, but has spread successfully to such functions as coal handling, coal combustion, and frequency control. No doubt additional functions will be taken over by automatic equipment. **(A.I.E.E. paper No. 32-89)**

Vibration and Fatigue in Electrical Conductors

By A. E. Davison[28] J. A. Ingles[28] V. M. Martinoff[28]

VIBRATION in electrical conductors is discussed in this paper. Stress is placed upon the necessity for the development of some new types of conductor which will, because of their shape or some inherent quality, resist more successfully than standard sections, the tendency to vibrate and the tendency to fail because of resulting fatigue. A number of appliances have been put forward from time

24. American Gas & Electric Company, New York, N. Y.
25. United Engineers and Constructors, Inc., Newark, N. J.
27. Aluminum Company of America, Massena, N. Y.
28. Hydro-Electric Power Commission of Ontario, Toronto, Canada.

to time which tend to reduce the amount of vibration ordinarily observed in a span. They are usually called dampers. However, there has been very little work done in the study of preventives.

The research described in this paper covers the placing of various cables with special section in flowing water and calibrating the resulting vibrations. Some types of stranded conductor show a material reduction in the tendency to vibrate. Among those showing the greatest reduction are the twisted triangle, the twisted square, and three-strand wire. Experiments in water show from 50 to 90 per cent reduction in the amplitude of vibration, other things being as near equal as possible.

The experiments reported are considered only as directional, although a few practical conductor shapes approximating the twisted triangle have been developed and are now being tested in air. The practical difficulties which will be encountered in the use of conductors of this general type are discussed. **(A.I.E.E. paper No. 32-69)**

Transmission Line Vibration Due to Sleet

By J. P. Den Hartog[8]

PHENOMENA of vibration in transmission lines due to the action of a transverse wind are encountered most frequently at moderate wind velocities (about 5 miles per hr.) and are characterized by rather high frequencies (5 to 15 cycles per sec.) and small amplitudes (up to a few cable diameters). This type of vibration is caused by the "Kármán" vortices forming behind the wire and is well understood.

Another type of disturbance has been observed, which seems to occur with sharp winds of above 20 miles per hr. with great amplitudes (20 ft.), slow frequencies (1 cycle per sec. or slower), and mostly associated with sleet formation on the conductors. This phenomenon has been rightly described as caused by the change in shape of the conductor due to the ice coating and by the consequent change in aerodynamic lift.

It is the object of this paper to give an explanation of the effect and to show how the stability in this respect of a transmission line can be calculated from the results of an aerodynamic test where both the drag (wind force in the direction of the wind) and the lift (wind force perpendicular to wind direction) are determined for various angles of attack. The conclusions reached may be summarized as follows:

1. The slow vibrations of ice-coated transmission lines in a heavy wind can be explained as due to a certain aerodynamic instability.

2. The phenomenon is entirely different from, and has no connection with, the rapid vibrations observed in fair weather at moderate wind velocities.

3. It is shown that instability occurs when the slope of the "lift curve" is greater than the amplitude of the "drag curve."

4. It follows from the theory that a change in the span length or in the tension of the cable does not affect the phenomenon.

5. The behavior of a toy called the "aerial toubillion" is shown to afford a simple test by which the stability of various ice-coated sections can be determined. **(A.I.E.E. paper No. 32-91)**

Stress-Strain Studies of Transmission Line Conductors

By G. W. Stickley[27]

RESULTS of tensile stress-strain tests illustrating the actual behavior of various conductors used in bare overhead transmission lines, and the effect upon this behavior of certain factors such as repeated stressing and lay of the cable, are presented in this paper.

Tests show that stress in transmission line conductors is not proportional to strain throughout the range of stress to which the cable may be subjected, and which in some cases is as high as from 50 to 70 per cent of the ultimate strength. Also, the modulus of a cable cannot correctly be assumed the same as that of a single wire or rod because the actual modulus of elasticity the first time that stress was applied in the various tests was lower than that obtained the second time and usually both were less than the theoretical or commonly assumed values.

In composite cables such as ACSR which are composed of aluminum and steel wires, additional phenomena occur which are not found in tests of cable composed of a single material. These are caused essentially by the difference in extension at the elastic limit of the aluminum and steel. The different distribution of the two materials therefore results before and after initial loading.

It was found also that the actual increase in modulus resulting from application of stress depends upon the magnitude of the stress applied, the amount of increase becoming proportionately less as the value of stress was increased. Repeated application of the same stress caused no further increase after the first application. The initial modulus was affected slightly by the diameter of the coil into which the cable had been wrapped for handling. The actual modulus of a cable depended upon the length of lay of the component wires, the longer the lay the more nearly the modulus approached that of a single wire. In the design of a composite cable such as ACSR consideration is given to this effect by stranding the steel ore with the longest practical lay and the aluminum wires with the shortest possible lay, the result then being that the core carries a maximum share, and the aluminum a minimum share, of the total stress in the cable.

Lines have been designed in which, during erection, the conductors were stressed at a certain high load for several minutes, thus giving the cable its permanent modulus and set. The feasibility of doing this work at the mill was investigated but found impractical because subsequent handling of the cable resulted in the loss of much of the effect produced. **(A.I.E.E. paper No. 32-68)**

Vibration of Overhead Transmission Lines

By R. A. Monroe[29] R. L. Templin[29]

STUDIES of vibration of overhead conductors have been prosecuted vigorously for several years in laboratory and fields. The importance of magnitude and distribution of stresses in multiple-strand conductors led to the development of a unique method for measuring stresses in vibrating conductors in the laboratory under conditions closely simulating field conditions, and numerous schemes for effecting better stress distribution at conductor supports have been investigated. These tests have been facilitated by the development of special machinery. Field work has been conducted on special outdoor spans, and observations have been made also upon operating lines at widely separated locations.

Among the results which have been secured in these studies are the following:

1. Theoretical formulas expressing relationship between frequency, loop length, tension, and weight agree well with field observations. The Relf and Ower formula for frequency is substantially correct as indicated by tests embracing various cable sizes and wind velocities.

2. Any suspended cable, when conditions are favorable, will vibrate, as shown by records of frequency and amplitude for aluminum, copper, steel, and composite types. A feasible reduction in tension will not prevent vibration and would be of value chiefly in decreasing the direct stress.

3. A properly designed damper will reduce the amplitude of vibration to an amount which scarcely is visible. A formula by Bate states that input of energy from the wind varies directly as amplitude; therefore, an effective damper is required to absorb only a small amount of energy.

4. The efficiency of various types of dampers has been determined by comparison of the vibration of damped and undamped spans. The Stockbridge damper gave better results than any other type investigated, is simple in design and construction, has no moving parts, and is easy to install even on hot lines. To perfect the design and extend to range of application, this damper has been subjected to extensive tests.

5. Experiments on eccentric cable shapes and cables of different stranding show that a rough exterior surface reduces amplitude but do not indicate that a vibrationless cable can be evolved.

6. Variation in vertical load at a suspension camp has been measured but was found to be relatively small in magnitude.

7. Armor rods are primarily reinforcement, although they reduce the amplitude of vibration approximately from 10 to 20 per cent.

8. Adequate practical protection against damage from vibration of conductors is afforded by proper use of armor rods or dampers. **(A.I.E.E. paper No. 32-90)**

29. Aluminum Company of America, Pittsburgh, Pa.

News

Of Institute and Related Activities

Summer Convention Program Extended

FINAL arrangements for the 48th annual summer convention of the Institute to be held at Cleveland, Ohio, June 20–24, 1932, now have been made by the Cleveland national convention committee. Advance notices have been mailed by this committee, which requests that all interested parties send in the return cards supplied. These include the advance registration card, one for hotel registration, and another for sports. As previously announced, there will be no registration fee for the main convention program.

In connection with the entertainment features of the convention, there will be a charge of $5 per person, payable upon registration, covering all entertainment features except greens fees. The special feature on Thursday, June 23, at Nela Park, and including various field events, dinner, and dancing, is covered by this fee. This feature extends through the afternoon and evening of one day, replacing the usual formal banquet.

Technical Sessions

In addition to the technical papers as given in the announcement for the summer convention in ELECTRICAL ENGINEERING for May 1932, p. 346–8, the following papers have been added:

CHARACTERISTICS OF SURGE GENERATORS IN RELATION TO THEIR APPLICATION TO THE SURGE TESTING OF TRANSFORMERS, P. L. Bellaschi, Westinghouse Electric & Mfg. Co.

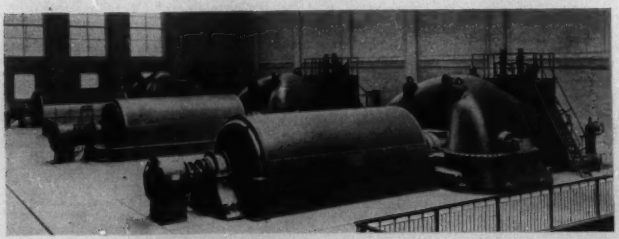
CURRENT PROPAGATION IN ELECTRIC RAILWAY PROPULSION SYSTEMS, John Riordan, American Telephone & Telegraph Co.

REPORT ON TELEMETERING, SUPERVISORY CONTROL AND ASSOCIATED COMMUNICATION CIRCUITS, subcommittee of committee on automatic stations, D. W. Taylor, *chairman*, and committee on instruments and measurements, E. J. Rutan, *chairman*.

The paper by P. L. Bellaschi has been added to the Wednesday morning session on electrical machinery; the paper by John Riordan, to the Thursday morning session on selected subjects and technical committee reports; and the report on telemetering and supervisory control, to the Friday morning session on automatic stations.

One feature of interest in connection with the technical program is that all technical sessions are to be held in the morning, leaving all afternoons free for inspection trips and the various entertainment features.

Ashtabula Plant to Be Visited During Convention



AMONG the numerous inspection trips arranged for the summer convention of the Institute at Cleveland, Ohio, June 20–24, 1932, is a visit to the Ashtabula steam-electric generating plant of the Cleveland Electric Illuminating Company, the turbine-generator room of which is illustrated above. Three 50,000-kw. units are shown, the first of which was placed in service late in 1930, and the other two in the spring of 1931. These are 1,800-r.p.m. machines generating at 13.2 kv.

Plans Progressing for Pacific Coast Convention

VANCOUVER, BRITISH COLUMBIA, scene of this year's Pacific Coast convention of the Institute, August 30 to September 2, 1932, has a natural setting difficult to describe adequately. Situated in country striking for its strong contrasts in scenery, it has as well a remarkably temperate climate and excellent facilities for practically every kind of sport and recreation.

In addition to the fine recreational program which the convention committee is preparing, the technical program now practically is completed. Feature topics scheduled for the meeting are:

1. Power generation.
2. Communication.
3. Transportation.

Power generation includes papers on the British Columbia Electric Power System and the Rock Island development on the Columbia River of the Puget Sound Power Company. An interesting discussion on segregation of hydroelectric power costs also is expected. Short-wave radio transmission will be dealt with, and radio links in the British Columbia Telephone Company's system will be described. Railway electrification will be taken up in two papers presenting different angles of the subject. Other topics include corona loss investigations up to 600-kv., zero error current transformers, factory assemblies for substations, metering of symmetrical components, triple harmonic residual effects in transmission systems, and other equally interesting subjects.

With regard to hotel accommodation, very reasonable rates have been arranged as follows with the Hotel Vancouver, convention headquarters:

Double bedroom with bath	$6.00
Single bedroom with bath	4.00
Double bedroom without bath	5.00
Single bedroom without bath	3.00

Hotel officials are cooperating with the committee and in addition to reserving a number of rooms for the convenience of Institute members, arrangements have been made to insure the comfort of all visitors.

No special travel rates have been arranged, since at the time of the convention the summer rates will be in force. Consideration should be given also to the fact that a holiday spent in British Columbia will be cheaper this year than usual, owing to the present rate of exchange.

Directors Meet at National Headquarters

The regular meeting of the board of directors of the American Institute of Electrical Engineers was held at Institute headquarters, New York, May 20, 1932.

Present were: *President*—C. E. Skinner, East Pittsburgh, Pa.; *Past-President*—W. S. Lee, Charlotte, N. C.; *Vice-Presidents*—H. P. Charlesworth, New York, N. Y.; W. E. Freeman, Lexington, Ky.; W. B. Kouwenhoven, Baltimore, Md.; I. E. Moultrop, Boston, Mass.; P. H. Patton, Omaha, Neb.; G. C. Shaad, Lawrence, Kans.; *Directors*—L. W. Chubb, East Pittsburgh, Pa.; A. B. Cooper, Toronto, Ont.; J. Allen Johnson, Buffalo, N. Y.; A. E. Knowlton, New York, N. Y.; A. M. MacCutcheon, Cleveland, Ohio; F. W. Peek, Jr., Pittsfield, Mass.; C. E. Stephens, New York, N. Y.; R. H. Tapscott, New York, N. Y.; H. R. Woodrow, New York, N. Y.; *National treasurer*—W. I. Slichter, New York, N. Y.; *Assistant national secretary*—H. H. Henline, New York, N. Y.

Minutes of the meeting of January 27, 1932, were approved.

Resolutions formulated by the executive committee in March, in memory of Past-President Harold B. Smith and National Secretary F. L. Hutchinson, were adopted as resolutions of the board. Tributes to Mr. Hutchinson from Sections and individuals were read.

Minutes of the meeting of the executive committee held March 9, 1932, were presented, and the actions taken at that meeting were ratified. The following actions of the executive committee on applications also were ratified: 1 applicant was elected to the grade of Fellow and 8 applicants to the grade of Member; 4 were transferred to the grade of Member; 233 were elected to the grade of Associate; 91 Students were enrolled.

Reports of the April 13 and May 18 meetings of the board of examiners were presented and the actions taken at those meetings were approved. Upon the recommendation of the board of examiners, 6 applicants were elected to the grade of Member and 13 were transferred to the grade of Member; 163 Associates were elected; 148 Students were enrolled.

The assistant national secretary reported 2,338 members in arrears for dues for the year ended April 30, 1932, and was directed to remove the names from the mailing list after the distribution of the June and July issues of ELECTRICAL ENGINEERING, and to employ the usual methods of collecting the dues and restoring the members to the active membership list. He also reported that on April 30, 1932, 1,018 members (6 Fellows, 85 Members, and 927 Associates) were dropped from the membership list, for non-payment of dues for the fiscal year which ended April 30, 1931.

The board of directors ratified the action of the finance committee in approving, for payment, monthly bills amounting to $22,214.12.

Upon the recommendation of the standards committee, approval was given, as sponsor, of three reports on symbols developed by the A.S.A. sectional committee on scientific and engineering symbols and abbreviations, as follows: "Graphical Symbols Used in Radio," "Graphical Symbols Used for Electric Power and Wiring," and "Graphical Symbols Used for Electric Traction Including Railway Signaling."

The report of the committee on award of institute prizes covering the awards made for the year 1931 was presented, as published elsewhere in this issue.

The annual report of the board of directors for the fiscal year ended April 30, 1932, as prepared under the direction of the assistant national secretary, was considered and approved for presentation at the Annual Meeting of the Institute, Cleveland, June 20.

The national treasurer presented a report covering the fiscal year just closed. Annual reports were received from the general standing committees (exclusive of the technical committees' reports, which will be presented at the summer convention in June and are published elsewhere in this issue). Abstracts of these reports were incorporated in the annual report of the board of directors.

The board by unanimous action appointed H. H. Henline as acting national secretary of the Institute, beginning June 1, 1932.

Representatives were appointed as follows: Bancroft Gherardi to the John Fritz Medal Board of Award, succeeding the late Prof. Harold B. Smith, and H. H. Henline to the Assembly of American Engineering Council, as successor to F. L. Hutchinson.

Announcement was made of the appointment of Institute representatives upon a joint committee of the United Engineering Trustees, Inc., and the national societies of civil, mining and metallurgical, mechanical, and electrical engineers to consider the subject of coordination of the various engineering organizations.

It was voted to hold the June meeting of the board of directors in Cleveland, on Wednesday, June 22.

Other matters were discussed, reference to which may be found in this and other issues of ELECTRICAL ENGINEERING.

H. H. Henline Appointed Acting National Secretary

By unanimous action of the board of directors of the American Institute of Electrical Engineers at its regular meeting held May 20, 1932, Henry Harrison Henline, since 1927 assistant national secretary, became acting national secretary of the Institute, effective June 1. In his new capacity, Mr. Henline takes over the executive duties for twenty years performed by the late F. L. Hutchinson.

For many years Mr. Henline has been interested in and actively associated with Institute work and, prior to his affiliation with the national headquarters staff, he made numerous contributions to its published technical works. He was elected to membership in 1919, and has served as chairman of the San Francisco Section (1922–23); faculty counselor for the Student Branch at Stanford University, Calif., (1926); chairman of the Committee

H. H. Henline

on Student Activities for the Pacific District—California, Arizona, Nevada—(1926); and as a member of the Sections committee (1923–27). Since joining the staff January 1, 1927, Mr. Henline has served as the Institute's representative on the American Year Book Advisory Board (1927–32); the American Standards Association (alternate representative 1929–32); Joint Committee on State Engineering Councils (1932–33); and has served on the Institute's Education committee (1929–32). He now becomes a representative of the Institute on the Assembly of the American Engineering Council. While he has been on the headquarters staff, Mr. Henline has participated in many phases of the Institute's work, but has devoted his principal attention to the work of its 60 Sections and 109 Branches.

Mr. Henline was born at Colfax, Ill., March 12, 1889, and after attending local grammar and high schools entered the University of Illinois in 1910, graduating in 1914 with the degree of Bachelor of Science in Electrical Engineering. After serving for a year as instructor in science and mathematics in the Oktaka, Okla., high school and as director of athletics for the Oktaka public schools, he entered the Chicago Central Station Institute of the Commonwealth Edison Company, graduating in 1916 and entering the commercial engineering department of the Illinois Maintenance Company of Chicago.

Joining the faculty of Stanford University in 1917 as an instructor, Mr. Henline later was promoted to assistant professor (1920) and to associate professor (1924) in the department of electrical engineering. In his work of instruction Mr. Henline gave at various times many courses in electrical engineering subjects, and was in charge of the machinery laboratory for five years and in charge of communication engineering for three years. He also was associated with

Dr. Harris J. Ryan in some of the high-voltage research that has made Stanford famous. He is author of a paper on engineering education, a paper on a standard-frequency radio station, and joint author of three papers on subjects relating to high-voltage electric power transmission.

Aside from the affiliations already given, Mr. Henline's organization memberships include the Society for the Promotion of Engineering Education, Institute of Radio Engineers (*Member*), American Association for the Advancement of Science (*Fellow*), Eta Kappa Nu, and Sigmi Xi.

North Eastern District Holds Eighth Annual Meeting at Providence

IN CONNECTION with its eighth annual meeting held May 4–7 at the Providence (R. I.) Biltmore Hotel, the North Eastern District, originator in 1924 of the District meeting idea, successfully conducted another possibly significant experiment in connection with the conduct of such meetings. Largely as an economy measure, but partly also in the interest of promoting better technical sessions, the District committee dispensed with the traditional advance pamphlet copies of the technical papers presented. As for economy, a substantial reduction was achieved in the cost of the meeting to the Institute; as for the effect on technical sessions, they were obviously improved by the more carefully prepared presentations of the various authors.

Accepting frankly the necessity for economy, the District meeting committee sought diligently for ways and means of achieving the desired reduction in meeting expense that would interfere the least with a successful meeting program, and at the same time best serve the average member of the Institute. The committee considered many possibilities, including a reduction in the number of meeting sessions and a reduction in the number of papers presented per session, but finally decided that the best interests of all concerned would be served most effectively by dispensing instead with the traditional publication of pamphlet copies for advance distribution and for circulation at the meeting. Also supporting this decision was the fact that the substance of the more important papers of general interest would be circulated throughout the membership in current issues of ELECTRICAL ENGINEERING (in addition to advance publication therein of comprehensive abstracts of all papers), and that the full text and related discussion of all papers so recommended by the technical program committee would be scheduled as usual for inclusion in the September issue of the Transactions.

Further influencing the North Eastern District meeting committee's decision to experiment with the Providence meeting was a strong and growing belief held by a good many active Institute members that the traditional habit of having convention sessions depend primarily upon the presence of pamphlet copies distributed throughout the audience is seriously injuring the quality and general interest value of the sessions. Knowing that the audience facing them either is reading or has read the dissertation about to be presented has caused most authors to give exceedingly sketchy and unfortunately uninteresting oral résumés of their papers. This situation was notably absent at the Providence meeting where nearly every author made an interesting and understandable presentation of his subject. Many, speaking upon the more complicated subjects, simplified and enlivened their presentation by strategic use of lantern slides reproducing diagrams, tabulations, and other illustrations throughtfully coordinated with their oral presentations.

As for the effect upon those attending the sessions, the Providence experiment produced reactions ranging all the way from one extreme to the other, as might be expected. Some few were notably antagonistic to the idea, while a few were equally ardently and unqualifiedly in favor of its wide adoption. Perhaps the principal significance of the experiment lies in the facts that discussion was active, pertinent, and interesting; and that the expressed opinion of many persons attending the various sessions was preponderantly to the effect that the sessions were notably improved. While there was no official expression of opinion in connection with the experiment, the opinion was vigorously expressed to the effect that the full possibility of benefits should be plumbed by a further prosecution of the experiment in connection with other meetings

TECHNICAL SESSIONS

The four general technical sessions embraced papers as announced in the April issue of ELECTRICAL ENGINEERING: various electrophysical subjects, presided over by Dr. Vannevar Bush; induction and synchronous motor problems, presided over by P. L. Alger; a symposium on traffic control, guided by Prof. H. M. Turner (Yale); and a discussion of the theory involved in electric power transmission, with P. H. Chase presiding. In addition, one entire technical session was given over to the District student convention, with H. L. Wood, senior student from the university of New Hampshire, presiding. Papers presented by students were:

1. The Thyratron Tube for Field Excitation of Electric Generators and Motors, George Andrews, Rhode Island State College.

2. Communication at Five Meters, E. M. Dukat and A. V. Nelson, Yale University.

3. Design and Construction of a Television Receiver, D. W. Mack, University of New Hampshire.

4. Development of a Practical Television Receiver, W. S. Bachman and E. M. Wolf, Cornell University.

5. Electrical Characteristics of a High Voltage Testing Transformer, Messrs. Reiter, Jessel, and Quan, Harvard University.

6. Electricity in Modern Medicine, E. W. Schafer, Massachusetts Institute of Technology.

Sharing honors with the general-interest session devoted to traffic control, the student session enjoyed an attendance in excess of 100, about twice the attendance at the more technical sessions. William S. Lee, past-president of the Institute, was the feature speaker at the student session. The dual theme of his address was directed toward urging student engineers to give attention to economic and sociological subjects in addition to their technical studies, and to encourage them to face the present economic upheaval with the realization that valuable and important opportunities await the aggressive individual and organization.

At the close of the student session the judges reported prize winning papers as follows:

First, D. W. Mack, University of New Hampshire;

Second, E. M. Dukat and A. V. Nelson, Yale University;

Third, E. W. Schafer, Massachusetts Institute of Technology.

ENTERTAINMENT

Entertainment features and inspection trips were well planned and executed for both men and women. In addition to local points of historic interest, many enjoyed the trips through the plants of the Gorham Manufacturing Company, and the U. S. Rubber Company, and to the properties of the Narragansett Electric Company and the United Electric Railways Company. Women guests enjoyed a luncheon at the Wannamoisett Country Club, and several small parties took the opportunity to motor to Newport and other nearby points of interest. By courtesy of the Wannamoisett Country Club, members and guests attending the meeting enjoyed golfing privileges.

At an informal bridge party held Wednesday evening, President Skinner rather unexpectedly found himself in the rôle of a travel lecturer. Extemporaneously he took his highly attentive audience on a most interesting movie-monologue trip along the route that he recently had followed through Mexico and into Yucatan. The social climax of the District meeting came Thursday evening with the annual banquet and dance. There again Past-President William S. Lee delivered one of his inimitable discourses on matters non-technical, including poetry.

The Providence District meeting was handled under the very active generalship of District Vice-President I. E. Moultrop of Boston, who served as chairman of the District meeting committee. With Mr. Moultrop on that committee were A. C. Stevens, Schenectady, District secretary-treasurer; C. W. Henderson, chairman of the Syracuse Section; O. W. Briden, secretary of the Providence Section; R. W. Graham, chairman of the Niagara-Frontier Section; W. S. Maddocks, chairman of the Providence Section; J. P. McCann, chairman Worcester Section; R. G. Warner, chairman Connecticut Section; and F. C. Young, chairman Rochester Section.

Under the active, driving leadership of Vice-President Moultrop and Chairman Maddocks of the local committee, the various Providence sessions were conducted rigidly on the time schedule given in the program. When discussion lagged below a satisfactory minimum it frequently was

stimulated and when it began to exceed the bounds of the program schedule it was promptly called to a halt. Punctuality was the keynote of many of Vice-President Moultrop's several and pertinent comments, and it paid its dividend in the conduct of the sessions.

As chairman of the local committee, William S. Maddocks carried the major load of work in connection with the Providence meeting. Associated with Mr. Maddocks on that committee were O. W. Briden, in charge of hotels and registration; R. W. Herrick, in charge of entertainment features; Mrs. R. W. Herrick, in charge of women's entertainment; J. W. Keeney, in charge of finance; L. P. Kenneally, in charge of publicity; J. C. B. Washburn, in charge of inspection trips.

In spite of the highly specialized character of several of the sessions, a total of 252 persons attended the meeting according to the official registration (registration fee $1; 50 cents for students). These were grouped as follows:

Members	134
Registered guests	33
Women	20
Students	60
Student guests	5
Total	252

1932 Lamme Medal Nominations Due Nov. 1

SPECIAL attention is directed to the fact that the names of Institute members who are considered eligible for the Lamme Medal, to be awarded in the fall of 1932, may be submitted by any member in accordance with Section 1 of Article VI of the By-laws of the Lamme Medal committee, as quoted in the following:

> The committee shall cause to be published in one or more issues of ELECTRICAL ENGINEERING, or of its successors, each year, preferably including the June issue, a statement regarding the "Lamme Medal" and an invitation for any member to present to the national secretary of the Institute by November 1, the name of a member as a nominee for the medal, accompanied by a statement of his "meritorious achievement" and the names of at least three engineers of standing who are familiar with the achievement.

Each nomination should give concisely the specific grounds upon which the award is proposed, and also a complete detailed statement of the achievements of the nominee, to enable the committee to determine its significance as compared with the achievements of other nominees. If the work of the nominee has been of a somewhat general character in cooperation with others, specific information should be given regarding his individual contributions. Names of endorsers should be given as specified above.

The Lamme Medal, founded as a result of a bequest of the late Benjamin Garver Lamme, chief engineer of the Westinghouse Electric and Manufacturing Company (deceased July 8, 1924), provides for the annual award by the Institute of a gold medal—together with bronze replica thereof—to a member of the A.I.E.E. "who has shown meritorious achievement in the development of electrical apparatus or machinery"; and for the award of two such medals in some years if the accumulation of funds warrants.

The fourth (1931) Lamme Medal has been awarded to Giuseppe Faccioli (F'12) consulting engineer (retired), General Electric Company, Pittsfield, Mass., "for his contributions to the development and standardization of high-voltage oil-filled bushings, capacitors, lightning arresters, and numerous features in high voltage transformers and power transmission." Presentation will be made during the summer convention at Cleveland, Ohio, June 20–24, 1932.

Electrical Congress to Meet at Paris, July 4-12

On the occasion of the 50th anniversary of the first International Congress of Electricity, the Société Francaise des Electriciens, the Société Francaise de Physique, the Comité Electrotechnique Francais, and the Union des Syndicats de l'Electricité are organizing, under the auspices of the Commission Electrotechnique Internationale an "International Congress of Electricity," which will convene in Paris, Monday, July 4, 1932. The Congress is open to all persons who wish to participate either in a personal or official capacity.

All those wishing to join must advise the head office of the Congress at 134, Boulevard Haussmann, Paris, before June 15, and must remit at the same time one of the following sums:

1. Those who make a contribution of at least 1,000 French francs will be registered as *benefactor members*.
2. Those who pay a membership fee of 250 French francs will be registered as *subscribing members*.
3. Those who belong to the families of Congress members and who pay a membership fee of 50 French francs will be registered as *related members*.

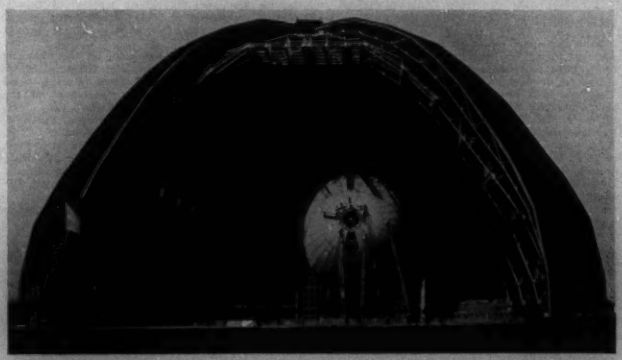
All payments must be drawn to the order of the Société Francaise des Electriciens, who is responsible for the treasury department.

Statements of the work of the Congress will be published in French, and will comprise the text of reports and papers and the reproduction, as exact as possible, of discussions. The transactions will be collected together in several volumes, and in due course interested parties will be advised of the distribution of the work of the thirteen Sections within these different volumes.

Whether or not they attend in person, Benefactor members will be entitled to receive free of charge the entire collection of transactions and, if desired, may take advantage of a discount of 25 per cent on the normal selling price for the purchase of supplementary volumes. Similarly, Subscribing members will be entitled to receive free of charge the volume or volumes containing the transactions of any one Section and can purchase, with a reduction of 25 per cent on the normal selling price, all or part of other volumes containing the transactions.

All persons particularly interested and desiring further information should at once

Goodyear Zeppelin Dock—On Convention Program



CONSIDERABLE popular interest has been evidenced in the inspection trip to Akron, Ohio, which is to take place during the coming summer convention of the Institute in Cleveland, June 20–24, 1932. During this trip a visit will be made to the hangars of the Goodyear Zeppelin Corporation, where the ZR-5 is in process of construction. The ZR-5 is still larger than its sister ship the giant dirigible "Akron," completed there last year. This trip will include also tours of any one of the three large rubber manufacturing plants in Akron; and following a supper at the Mayflower Hotel, the Barberton plant and laboratory of the Ohio Insulator Company will be visited. The outdoor laboratories of this company provide facilities for testing up to 1,000,000 volts, and insure an exhibition which will be instructive and interesting to both the engineers and women guests.

correspond directly with Dr. Harold Pender, Dean, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa.

Technical activities are divided into thirteen Sections as follows:

1. Electrical and magnetic science. General theories. Insulators. Conductors. Radioactivity. Magnetic bodies.

2. Electrical measurements: (a) Units and standards; absolute electrical measures. (b) Laboratory measurements; industrial measurements and experiments with machines.

3. Production and transformation of electrical energy.

4. Transmission and distribution of electrical energy.

5. Electrical traction. Mechanical applications.

6. Electric lighting. Photometry.

7. Electrochemistry. Electrometallurgy. Batteries and accumulators.

8. Telecommunications by wire (distant communications by wire).

9. High frequency current phenomena. (a) Radioelectricity. (b) Radio communications.

10. Radiobiology. Electrobiology.

11. Atmospheric electricity. Terrestrial magnetism.

12. Various applications of electricity.

13. Teaching and history of electricity.

Institute Prize Awards Announced for 1931 Papers

FOUR national prizes for papers presented during the calendar year 1931 have been announced by the committee on award of Institute prizes, which consists of W. H. Harrison (F'31) chairman, L. W. Chubb (F'21), A. E. Knowlton (F'30) and E. B. Meyer (F'27). These prizes in each case consist of $100 in cash and a suitable certificate; in cases of joint authorship the cash is divided. Personal presentation of the prizes will take place at the opening session of the Institute's summer convention at Cleveland, Ohio, June 20–24, 1932.

District prizes as announced by seven Districts include fifteen awards of $25 each, together with appropriate certificates. As in the case of the national prizes, where there is a joint authorship the cash awards are divided.

National Prizes

Best Papers

Prize for best paper in engineering practise, awarded jointly to authors of papers in symposium on coordination of power and telephone plant, composed of four parts as follows: "Trends in Telephone and Power Practise as Affecting Coordination" by W. H. Harrison (F'31) and A. E. Silver (F'26); "Status of Joint Development and Research on Noise Frequency Induction" by H. L. Wills (A'30) and O. B. Blackwell (F'17); "Status of Joint Development and Research on Low-Frequency Induction" by R. N. Conwell (F'31) and H. S. Warren (F'13); and "Status of Cooperative Work on Joint Use of Poles" by J. C. Martin (A'12) and H. L. Huber (M'23). This symposium was presented at the winter convention, New York, January 26–30, 1931.

Honorable mention was made of the following papers: "Synchronous Motor With Phase-Connected Damper Winding for High-Torque Loads" by M. A. Hyde, Jr. (A'27), presented at the winter convention, New York, January 26–30, 1931; and "Economics of High Voltage Cable" by D. W. Roper (F'14) presented at summer convention, Asheville, N. C., June 22–26, 1931.

Prize for best paper in theory and research, awarded to L. V. Bewley (A'27) for his paper "Transient Oscillations in Distributed Circuits With Special Reference to Transformer Windings" presented at summer convention, Asheville, N. C., June 22–26, 1931.

Honorable mention was made of the following papers: "Calculation of Synchronous Machine Constants—Reactances and Time Constants Affecting Transient Characteristics" by L. A. Kilgore (A'29) presented at the summer convention, Asheville, N. C., June 22–26, 1931; "Submarine Cable Telegraphy: Influence of Interference" by J. W. Milnor (F'30) presented at the winter convention, New York, January 26–30, 1931; and "An Experimental Lightning Protector for Insulators" by J. J. Torok (A'27) presented at the winter convention, New York, January 26–30, 1931.

No prize was awarded in the field of public relations and education.

Initial Paper

Prize for initial paper awarded to Ernst Weber (A'31) for his paper "Field Transients in Magnetic Systems" presented at the summer convention, Asheville, N. C., June 22–26, 1931.

Honorable mention was made of the following papers: "Extinction of Short A-C. Arcs" by T. E. Browne, Jr. (A'31) presented at the summer convention, Asheville, N. C., June 22–26, 1931; "The San Francisco-Los Angeles Section of the Pacific Coast Telephone Cable Network" by E. M. Calderwood (M'24) and D. F. Smith (A'31) presented at Pacific Coast convention, Lake Tahoe, Calif., August 25–28, 1931, and "Temperatures in Electric Power Cables Under Variable Loading" by E. A. Church (A'29) presented at the North Eastern District meeting, Rochester, N. Y., April 29–May 2, 1931.

Branch Paper

Prize for branch paper awarded to J. R. Batcheller for his paper "Abridged Method of Testing Welds" presented at the joint meeting of the Portland Section and Oregon State College Branch, May 23, 1931.

Honorable mention was made of the following papers: "Accumulation of High-Potential Static Charges on Transmission Lines During Sand Storms" by C. E. Houston, presented at the South West District Meeting, Kansas City, Mo., October 22–24, 1931; and "Influence of Preservatives on the Dielectric Strength of Wood" by C. B. Parsons and M. H. Tipton, presented at a joint meeting of the Portland Section and Oregon State College Branch, May 23, 1931, and at the Pacific Coast convention, Lake Tahoe, Calif., August 25–28, 1931.

District Prizes

District No. 1

Prize for best paper awarded to P. H. Moon (M'29) for his paper "The Theory of Thermal Breakdown of Solid Dielectrics" presented at the North Eastern District meeting, Rochester, N. Y., April 29–May 2, 1931.

Prize for initial paper awarded to E. A. Church (A'29) for his paper "Temperatures in Electric Power Cables Under Variable Loading" presented at the North Eastern District meeting, Rochester, N. Y., April 29–May 2, 1931.

Prize for Branch paper awarded jointly to D. C. Robinson and R. W. Stone for their paper "A Study of Torque-Time and Slip-Time Relations of an Induction Motor Flywheel Set Operating on a Mine Hoist" presented at the North Eastern District meeting, Rochester, N. Y., April 29–May 2, 1931.

Honorable mention was made of the paper "The Theory of the Capacitance Potentiometer" by A. W. Moon and W. E. Brainard, presented at the North Eastern District meeting, Rochester, N. Y., April 29–May 2, 1931.

District No. 2

Prize for best paper awarded to W. P. Taylor (A'26) for his paper "Locating Power Cable Faults by Means of a Constant-Current Transformer With Short-Circuiting Switch" presented at a meeting of the Baltimore Section, May 15, 1931.

Prize for initial paper awarded to W. P. Taylor (A'26) for his paper "Locating Power Cable Faults by Means of a Constant-Current Transformer With Short-Circuiting Switch" presented at a meeting of the Baltimore Section, May 15, 1931.

District No. 6

Prize for Branch paper awarded jointly to C. A. Church and N. R. Damon for their paper "New Ideas for High-Voltage Circuit Breakers" presented at a joint meeting of the Denver Section and University of Colorado Branch, April 24, 1931.

District No. 7

Prize for Branch paper awarded to C. E. Houston (A'32) for "Accumulation of High-Potential Static Charges on Transmission Lines During Sand Storms" presented at the South West District meeting, Kansas City, Mo., October 22–24, 1931.

District No. 8

Prize for best paper awarded to W. S. Peterson (M'29) for his paper "Calculation of Dynamic Power Limit of Transmission System During Three-Phase Faults" presented at a meeting of the Los Angeles Section, February 17, 1931.

Prize for initial paper awarded to V. A. Hoover (A'32) for his paper "Correlation of Induction Motor Design Factors" presented at the Pacific Coast convention, Lake Tahoe, Calif., August 25–28, 1931.

Prize for Branch paper awarded to E. W. Palmrose for his paper "Vacuum Tube Voltage Regulators" presented at Pacific Coast convention, Lake Tahoe, Calif., August 25–28, 1931.

District No. 9

Prize for best paper awarded to A. Shipek (M'29) for his paper "Analysis of Distribution Substation Costs" presented at a meeting of the Seattle Section, May 19, 1931.

Prize for initial paper awarded to J. L. Watson (A'17) and R. C. Gleeson for their paper "A Special Application of the Potentiometer Principle" presented at a meeting of the Portland Section, December 8, 1931.

Prize for Branch paper awarded to J. R. Batcheller for his paper "Abridged Method of Testing Welds" presented at a joint meeting of the Portland Section and Oregon State College Branch, May 23, 1931.

District No. 10

Prize for best paper awarded to G. L. Lillie (A'21) for his paper "Factors in Design of 115–230-Volt Distribution in a Modern Residential District" presented at a meeting of the Toronto Section, March 27, 1931.

Prize for initial paper awarded to G. L. Lillie (A'21) for his paper "Factors in Design of 115–230-Volt Distribution in a Modern Residential District" presented at a meeting of the Toronto Section, March 27, 1931.

Plans for the Allocation of Sales Effort.—As an aid in planning the approach to that portion of the industrial market found in manufacturing plants, the United States Department of Commerce recently released a bulletin "A Basis for Establishing Industrial Sales Territories." In announcing the bulletin, the department stated "To the experienced analyst this material will mean more up-to-date data upon which to adjust and check his present plan of allocating sales effort. However, to those charged with the responsibility of sales promotion in firms which have not established a marketing research department, the data undoubtedly will provide an inexpensive method of establishing quickly a fairly accurate marketing program." Copies may be purchased at 10 cents each from the Supt. of Documents, Govt. Printing Office, Washington, D. C.

California Approves the Common Neutral

The use of a single combined neutral conductor for electric power distribution circuits operating at a potential of 5 kv. or less, has been approved by the California Railroad Commission for overhead construction, wherever feasible within that state, according to a news item in the May 1, 1932, issue of *Electrical West*. This decision comes after two and one-half years of intensive and extensive study and field tests, conducted under the supervision of the commission and with the cooperation of power and communication utilities and the National Electric Light Association. C. T. Mess (M'29) supervised the work for the commission.

One of the principal controversial points settled by the investigation and subsequent decision was the matter of telephone interference that might be caused by the new type of construction. The matter of safety was given close attention also, resulting in findings that, under the commission's construction specifications, the common-neutral system may be expected to be at least as safe for employees and the general public as the separate-neutral construction, and in many cases safer.

Summer School for Engineering Teachers

Maintaining its previous practise, the Society for the Promotion of Engineering Education is planning to hold two summer school sessions for engineering teachers during July of this year. One session will be devoted to the study of economics and is to be held at Stevens Institute of Technology, Hoboken, N. J., July 5–21, 1932; a session on English is to be held at the Ohio State University, Columbus, Ohio, July 11–28, 1932. A registration fee of $10 will be charged for each session. Room and board at Stevens will be $50 per person for the period of the session; at Ohio State, $42 per person for the session. In both cases special arrangements will be made for those teachers who are accompanied by their wives.

Improvement of the teaching of engineering is stated as the general purpose of these sessions. Each session will be devoted to a study of the methods of teaching its particular subject or division of the engineering curriculum. Further information may be had from Frederic L. Bishop (A'13), secy., University of Pittsburgh, Pittsburgh, Pa.

Electrification Report Issued

Electrification of steam railways throughout the world is covered exhaustively in the latest report of the railway electrification committee of the National Electric Light Association. This report is the fifth the committee has issued since a detailed study of steam railroad electrification was begun in 1926. Britton I. Budd, president of the Public Service Company of Northern Illinois, is chairman of the committee, and H. H. Field (A'14, M'28) is secretary.

Length of Railroad Track Electrified

Country	Miles Route	Miles Main Track	Miles All Tracks
United States	2,055	3,597	4,911
Switzerland	1,542	2,105	2,929
Italy	1,079	1,620	2,218
France	1,046	1,736	2,234
Germany	972	1,647	2,373
Sweden	726	791	1,039
Austria	564	794	927
Great Britain	474	1,122	1,234
Spain	369	560	650
Australia	261	568	701
Brazil	251	272	319
Japan	248	441	569
India	222	455	689
Chile	208	242	365
World total	11,318	17,728	23,567

The length of railroad track electrified, summarized in the accompanying table, is analyzed for the various countries. Existing electrifications are described, and among the new projects discussed are those of the Lackawanna, Reading, New York Central, and Pennsylvania railroads. After analyzing conditions in other countries, the report concludes with a study of the methods by which power is supplied to all the electrifications in the United States.

Statistics on Consumer Markets

Newest data available indicating the location, size, and purchasing power of domestic markets for the products of American industry are presented in a report "General Consumer Market Statistics," made public by the Department of Commerce April 14, 1932. The report is published as the first supplement to the "Market Data Handbook of the United States" recently made available, and brings up to date the statistical information relating to the consumer market section.

Approximately how much money the people of a given section maintain in the bank, what proportion of them file income tax returns, how many automobiles they own, the number of wholesale and retail outlets that serve them—are a few of the fundamental factors entering into an appraisal of marketing possibilities which this new supplement brings together. Population, both city and rural, is shown for each county in the country as of the 1930 census count. Value of manufactured products, value added by manufacture, and worth of mine output, are reported on the basis of 1929 returns. Savings, deposits, postal receipts, and users of telephones, also are reported in terms of counties.

A large number of other tables and maps

Two Electric Locomotives Shipped to U.S.S.R.

TWO complete electric locomotives, the first of eight for service on the Transcaucasian Railway in the U.S.S.R., have just been shipped from the Erie (Pa.) Works of the General Electric Company. Weighing 145 tons each, these two locomotives required six flat cars to transport them from the factory to New York, whence they were sent by ship to the Port of Batum through the Mediterranean Sea. The Transcaucasian Railway is part of the government owned system of the U.S.S.R.; it extends through the Suram Pass, the electrified section being about 40 miles in length, and including heavy grades. The locomotives, intended for both freight and passenger service, are of the six-axle type, and will be capable of being coupled together to form units of 290 tons and 5,400 hp., among the most powerful in Europe. Regenerative braking is provided. Tests on the locomotives are expected to be carried out during June, with complete electrical operation of the mountain section scheduled to begin in October of this year.

is given, some of these indicating the changes which have taken place since publication of similar data.

The "General Consumer Market Statistics" is published as part of a general program for providing American business with basic information which will enable the individual concern to increase the efficiency of its sales and marketing methods, and thus help to reduce wastes in the national distribution system. This publication may be purchased at 60 cents per copy from the Superintendent of Documents, Government Printing Office, Washington, D. C., or any of the district offices of the bureau located in principal cities. Copies of the third printing of "The Market Data Handbook" are available at $2.50 per copy.

Letters to the Editor

The Forces of Ignorance

To the Editor:

I have frequently in the past few months seen references to "the forces of ignorance, tradition" and so on, in various ELECTRICAL ENGINEERING articles; and now again in the March issue in Doctor E. W. Rice's address, as recorded on page 197, we have—"The forces of ignorance, tradition, and superstition are strong and view with some alarm the progress of science" . . . "After all, the forces of reaction and ignorance cannot prevail permanently in a country in which the voters are properly educated."

Now, I for one of the readers of ELECTRICAL ENGINEERING would like to know just what these "ignorant, superstitious forces" are. Enough of this vague generalizing; if such forces exist let's have them named and combat them like intelligent beings, if they should be combated.

Yours truly,

FRANCIS L. BURKE (A'28)
(Mfg. Planning Engr., Western Elec. Co., Kearney, N. J.)

Has Man Benefited by Engineering Progress?

To the Editor:

Through engineering progress man has revolutionized transportation and communication. He has harnessed the forces of nature and commands them do his bidding. He has appropriated for his use and entertainment all the marvelous inventions, developments, and improvements in the electrical, mechanical, chemical, and civil arts and sciences. Through engineering progress man has lightened his labors, increased his hours of leisure, expanded his means of entertainment, and increased his vision. But has man benefited by engineering progress?

This question cannot be answered affirmatively by merely enumerating the tremendous increase in economic wealth brought about by engineering progress. It is first necessary to come to an understanding of the significance of the word "benefited," the definition of the word being of but little assistance. The implication of the word "benefited" in any particular case is quite clear: a patient is benefited by the medical ministration that relieves his pain or restores his health, a sorely fatigued person is benefited by rest, a hungry person by food, the lonesome by companionship. But the patient aggravated by the best of potions, the man forced into idleness by unemployment, the farmer glutted with a surplus of food, the socially-lionized surfeited with companionship, certainly are not benefited. The objective, the result sought, as compared to that obtained, becomes a measure of the beneficialness of a man's acquisitions; it must result in a want satisfied.

Engineering progress is conceded by all to be the most powerful influence in the life of modern man. His work, his travel, his amusement, and his rest; his life and his health; his political, his social, and his home life, have all been affected or better still revolutionized. How can the benefit of such a deep and wide spread influence be measured? It can be done by finding man's objective, man's primary want and then inquiring as to what extent engineering progress satisfied that want. This primary want is, without question, happiness. Whatever man does, he does so because he thinks or believes that it will enhance his happiness. Even if his actions be entirely altruistic there is no denying the fact that he gains a measure of personal satisfaction from that act.

In the light of this primary want, has man benefited by engineering progress? The answer is that he has benefited but little, if at all. There are no available statistics to verify the truth or falsity of this statement. It is, however, easily observed that the greater happiness prevailing at the crest of a business cycle due to the higher standard of living made possible by engineering progress, is matched by an equal amount of misery at the trough of the same cycle; the latter seems to be in direct proportion to the former.

The man who has owned an automobile is as miserable when he can no longer afford the luxury, as the man who is compelled to move to a less pretentious apartment. It is the stepping down from an accustomed standard that brings on the state of unhappiness and not the particular height of the standard. This is attested to by the many visitors to our shores coming from less industralized countries. Each one would consider our present standard a godsend for his nationals. Several months ago an Englishman, upon leaving our shores, said that England would be a happy land if it were afflicted with the American depression. It is evident, therefore, that it is not the absolute status of the standard but the drop of same that hurts. Happiness during the rise is, therefore, offset by the unhappiness during the drop, leaving but a small sum total of benefit from engineering progress.

Engineering progress has been sporadically raising that standard; but the engineering profession, I regret to say, has made no attempt to so plan the progress as to make the rise smooth and uniform. Engineers have contributed all of the technical progress of mankind but have left to others the management or rather mismanagement of their contributions. Even to the present day many engineers look askance at the political and social activities of the professional engineering associations.

The engineer, accustomed to long-range planning, familiar with the industrial machine he has built, peculiarly trained for the job, should take a greater hand in the management of affairs. The national engineering societies could help much in bringing the engineer out of his purely technical shell. Assuming a little responsibility in investigating conditions, and the causes for same, and doing some planning for the future, and giving properly worked out plans suitable publicity, will certainly not hurt the engineering profession. In due time it may perhaps definitely be said that man is benefiting by engineering progress.

Yours very truly,

JACOB KATZMAN (A'20)
(Consulting Engr., Dumont Elec. Co., New York, N. Y.)

Injuries From Electric Shock

To the Editor:

Referring to letters upon the general subject of vivisection that you have recently published, permit me a suggestion.

To alleviate the suffering of human beings we must have knowledge of a type that can be obtained only by experiment upon living organisms. The organisms may be either human or animal. When a human organism objects to the use of animal organisms for the benefit of himself and other human organisms, I think that it would be entirely proper for him to offer himself as a subject for the necessary experiments. Surely the objector will be willing to display in so practical a manner the humanitarianism that he has expressed with such feeling on paper.

I commend this suggestion to the attention of all those who would rather see a thousand children suffer than to have one of the lower animals put out of the way, under proper safeguards, to save the kids.

Very truly yours,

H. H. KETCHAM (A'13, M'23, Life Member) (Technical Editor, Forest Products Lab., Madison, Wis.)

Injuries From Electric Shock

To the Editor:

I was very much interested in the articles by Dr. Kouvenhoven and others discussing the nature of injuries from electric shocks. All the utility engineers who have had occasion to testify in lawsuits involving personal injury, or who have heard the medical profession testify in such suits realize the lack of available information at the present time.

We are hopeful that experimental work will be continued and that the results will be made available to the electrical profession, as in the past.

Yours very truly,

E. E. GEORGE (A'20, M'29)
(Supt. of Electrical Operation, Tennessee Elec. Pwr. Co., Chattanooga, Tenn.)

American Engineering Council

Public Works Administration

The possibility of securing a public works administration during this session of Congress was greatly enhanced by the action of the House of Representatives on the omnibus economy bill. A special rule was obtained making the bill a part of the legislative appropriation bill, which will insure action upon its provisions by the Senate during this session of Congress. Title V of the bill authorizes the formation of the public works administration under an administrator who shall hold office for six years, and receive a salary of $10,000 per year. In its present form the bill provides that the rivers and harbors activities of the War Department be excluded from this administration. In passage through the house, but two minor perfecting amendments were made to this section, the effect of which was to make the provision applicable only to the officers of the corps of engineers and not to enlisted or civil service personnel.

The A.E.C. has sponsored several amendments to Title V of the bill to the effect that:

1. The term of office of the administrator of public works be extended to at least ten years.

2. Inasmuch as the administrator will deal with highly technical questions, definite stipulations as to his qualifications should be included in the bill.

3. Rivers and harbors work of the War Department should be under the administrator of public works.

4. The administrator of public works *may* (not *shall*) utilize the services of the corps of engineers of both the United States Army and Navy whenever and wherever practicable.

5. The administrator of public works be given authority to employ as special consultants, experts without civil service status.

The bill is now before the Senate where it is certain to receive some action within the near future. It seems highly probable that the Senate either will amend Title V or strike the entire section from the bill. Should this latter action take place, the president would have ample opportunity under another provision of the bill to group and consolidate into one given department all of the executive agencies having to do with public works construction.

Muscle Shoals Bill Passed by House.—On May 5, 1932, the House of Representatives passed the Muscle Shoals bill (HR11051). In many respects this bill is similar to the one vetoed by President Hoover last year, providing that the government may lease Muscle Shoals properties under certain conditions; in the event of its inability to lease the properties before a given time, the bill provides that they may be operated by the government.

A.E.C. Gets New Member.—The Society for the Promotion of Engineering Education recently became a member-organization of the American Engineering Council. This is regarded as an extremely important step in the development of the council inasmuch as the S.P.E.E. is the foremost exponent of engineering education in the United States.

Personal

ADOLPH SHIPEK (A'23, M'29) design engineer for the Puget Sound Power and Light Company, Seattle, Wash., has been awarded the A.I.E.E. North West District 1931 prize for best paper. Mr. Shipek, a native of the State of Wisconsin, received

ADOLPH SHIPEK

his preliminary schooling at Antigo, and in 1909 was graduated from the electrical engineering course at the University of Wisconsin, Madison. Upon completion of his college course, he became a student apprentice with the Allis-Chalmers Company. During the following year he was engaged in construction work on the White River hydroelectric plant of the Puget Sound Power and Light Company, Seattle, Wash., and in 1911 he became draftsman on electrical substation installation for that company, continuing in this capacity for a period of four years. In 1918 he became chief electrician for the Norway Pacific Construction and Dry Dock Company at Everett, Wash. Two years later he was chosen mechanical and electrical draftsman for the Seattle School District, and was employed by the City of Seattle on its Skagit hydroelectric development. In 1921 he again became affiliated with the Puget Sound Power and Light Company, was made field engineer of that company in 1924, and later design engineer, the position he now holds.

GERARD SWOPE (A'99, F'22) president of the General Electric Company, Schenectady, N. Y., has received the Gold Medal award of the National Institute of Social Sciences, "in recognition of his public service in formulating the Swope plan for the stabilization of industry with a guarantee of employment." The address of presentation was made by Owen D. Young, at the organization's annual dinner at the Waldorf-Astoria Hotel, New York, N. Y. In his speech of acceptance Mr. Swope expressed a satisfaction with the country's courageous attitude during the past two years. "Our primary thought for today," he asserted, "is how to emerge from these trying and difficult times as rapidly and as equitably as possible... If we are to maintain confidence, which is so absolutely essential, a definite program should be adopted toward balancing the budget of each of the various units in our country."

J. L. WATSON (A'17) station meter tester for the Portland (Ore.) General Electric Company, has received the 1931 A.I.E.E. North West District prize for initial paper. Mr. Watson was born at Warren, Ohio, completed grade school and two years of high school at Meadville, Pa., then moved to Oregon and finished his high school course at Eugene. This was followed by a four-year course in electrical engineering at the University of Oregon (Eugene) from which he was graduated in 1915. After this he spent one term on a special course at Cornell University, Ithaca, N. Y., and a year on the General Electric test course at Pittsfield, Mass. At various times during his college years, Mr. Watson was employed as operator for the City of Eugene water works, for the Oregon Power Company at Eugene, and for the North Coast Power Company at Vancouver, B. C. He became affiliated with the Portland General Elec-

J. L. WATSON

tric Company in 1920 and has been in the employ of that company since that time. He has taken a keen interest in Institute affairs and has served on many committees of the Portland Section.

J. B. WHITEHEAD (A'00, F'12) dean of the School of Engineering, Johns Hopkins University, and a member of its faculty since its organization, has been honored twice recently. He has been elected to membership in the National Academy of Sciences, the total membership of which is restricted to approximately 150 persons; and he has been awarded the Franklin Institute's Elliott Cresson Gold Medal and certificate for his work in dielectrics. The Elliott Cresson award was established in 1848 and is given "for discovery or original research, adding to the sum of human knowledge irrespective of commercial value;

leading to practical utilization of discovery; and invention, methods of products embodying substantial elements of leadership in their respective classes, or unusual skill or perfection in workmanship." The first award of this medal was made in 1856.

E. A. CHURCH

E. A. CHURCH (A'29) who is now in the electrical engineering division of the Edison Electric Illuminating Company of Boston, Mass., was elected to receive the 1931 A.I.E.E. North Eastern District prize for initial paper. Mr. Church is a native of Franklin Grove, Ill. He was graduated from a cooperative course at Massachusetts Institute of Technology with the degree of S.M. in E.E. in June 1928. During his graduate year at M.I.T., Mr. Church was Swope Fellow in electrical engineering. He has been engaged with his present company ever since graduation, his work including various substation, transmission, and generation problems in connection with power system operation.

P. H. MOON (A'24, M'29) assistant professor in the electrical engineering department of Massachusetts Institute of Technology, Cambridge, Mass., has received the 1931 A.I.E.E. North Eastern District prize for best paper. A native of Beaver Dam, Wis., Mr. Moon was graduated from the University of Wisconsin in 1922 with the degree of B.S. in E.E. He was for a short while laboratory assistant for the Public Service Company of Northern Illinois at Joliet, Ill. After two years in the electrical and mechanical design schools of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., he joined the staff of M.I.T. in 1924 as research assistant. He has made several contributions to A.I.E.E. literature.

R. W. ALEXANDER (A'28, M'30) formerly with Allied Engineers, Incorporated, and later with the Consumers Power Company, both of Jackson, Mich., has resigned his position with the latter company to join the Anaconda Wire and Cable Company, New York, N. Y. While with Allied Engineers, Incorporated, Mr. Alexander was connected with system planning. He has served on the power systems engineering committee of the National Electric Light Association.

M. LUCKIESH (A'11, M'15) director of the General Electric Company lighting research laboratory at Nela Park, Cleveland, Ohio, recently received appointment to represent the United States National Committee on the technical committee on ultraviolet radiation of the International Commission on Illumination. The purpose of this committee is to define units and methods of measurement and for the appraisal of ultra-violet radiation.

F. D. WEBER (A'09, M'30) who has been serving the Oregon Insurance Rating Bureau at Portland, Ore., as chief electrical engineer, recently was elected president of the International Association of Electrical Inspectors, the headquarters of which are in Chicago, Ill.; he is also secretary-treasurer of the Northwestern Section of this same organization. In his office as president he succeeds R. H. Manahan (M'22) of Los Angeles.

RICHARD MCKAY (A'22) assistant electrical engineer for the Washington Water Power Company, Spokane, Wash., has been appointed district manager of that company's Coeur d'Alene, Idaho, operations, which includes both electric and water service. His affiliation with this company dates from 1921, following his graduation from Columbia University, New York, N. Y. Mr. McKay is also chairman of the Associated Engineers of Spokane.

D. C. ROBINSON (A'32) who is at present a graduate assistant at the College of Applied Science, Syracuse University, Syracuse, N. Y., recently in his joint authorship with R. W. Stone, was voted the 1931 prize for Branch paper in the Institute's North Eastern District. Mr. Robinson, a native of Newell, Iowa, entered Syracuse University as a student in the electrical engineering department in 1927 and received

D. C. ROBINSON

his B.S. in E.E. in 1931. In the fall of 1931, he engaged with the General Electric Company to begin work in its vacuum tube research laboratory at Schenectady, October 1932. He now is working for his M.S. in E.E., his major teaching subject at the College of Applied Science being descriptive geometry. During the period from September 1930 to June 1931, he was chairman of the A.I.E.E. Branch at Syracuse University and also was chairman of the North Eastern District meeting Student session at Rochester, N. Y., May 1, 1931.

GUGLIELMO MARCONI (HM'17) recently was the recipient of the 1932 Kelvin Medal, which is awarded triennially by the Institution of Civil Engineers of Great Britain. The Kelvin Gold Medal, being a tribute of engineers to the memory of Lord Kelvin, is awarded to men of distinguished service in the application of science to engineering rather than in the development of physical science itself. The first award was made in 1920.

FRANK WENNER (A'12, F'26) physicist, Bureau of Standards, Washington, D. C., recently was awarded the John Price Wetherill Medal, which The Franklin Institute presents annually "for discovery, invention, or development in the physical sciences." This medal award was established in 1925, for the promotion of research.

W. S. WATSON (A'28) for many years chief engineer and manager of the city water and light supply for Hastings, Neb., recently received his appointment as superintendent of the board of public works at Hannibal, Mo. In this office he will be in charge of the Hannibal municipal supply of water, light, and power.

C. E. ALLEN (A'04, F'14) who for some time served the Westinghouse Electric and Manufacturing Company as its southwest district manager, with offices at St. Louis, Mo., and who is at present its commercial vice-president at East Pittsburgh, Pa., recently was elected vice-president of the American Management Association.

F. J. BARTLEWSKI (A'28) who has been serving the International General Electric Company at Bucharest I., Roumania, now has been transferred by his company to Bombay, India. Prior to his work in Bucharest, Mr. Bartlewski was X-ray engineer for the General Electric X-Ray Corporation at Warsaw, Poland.

G. E. WOOD (A'26) for some time a member of the firm of Langner, Parry, Card, and Langner, patent attorneys in New York, N. Y., has located in Dublin, Ireland, as assistant patent agent for Cruickshank and Company, an organization which has been operating for over thirty years and closely allied with Mr. Wood's previous connection.

E. W. DAVIS (A'15, M'21) has been made electrical engineer for the Simplex Wire and Cable Company, Cambridge, Mass. He succeeds W. I. Middleton (A'09, M'14) who was forced to retire a short time ago because of ill health. Mr. Davis' previous office with the company was that of assistant electrical engineer.

J. C. PARKER (A'04, F'12) was recently appointed to the board of directors of the American Standards Association, to succeed M. S. Sloan (A'07, F'30) whose term

expired December 1931. Mr. Parker represents the electric light and power group on that board.

R. B. MAY (A'12) for several years has been vice-president and assistant managing director of the Overseas Motor Service Corporation, New York, N. Y.; now he has removed to Chicago to become curator of automotive engineering at the Museum of Science and Industry in that city.

H. W. FISHER (A'95, F'12) who is a Member for Life of the Institute and who for some time has been consulting engineer for the General Cable Corporation, located at Perth Amboy, N. J., now has retired from active service. His future address will be Laguna Beach, Calif.

W. J. BERRY (A'31) is now assistant equipment supervisor of the Southeast Missouri Telephone Company, and is located at Cape Girardeau, Mo. As a student engineer of the General Electric Company, Mr. Berry was located previously at Lawrence Park, Erie, Pa.

C. O. VON DANNENBERG (A'06, M'30) who formerly was assistant electrical engineer of the Electric Management and Engineering Corporation, New York, N. Y., recently became a member of the engineering department of the Pennsylvania Central Light and Power Company, Altoona, Pa.

C. M. GILT (A'21, M'26) outside plant engineer for the Brooklyn Edison Company, Brooklyn, N. Y., has received the appointment of assistant electrical engineer of that company. Mr. Gilt's first connection with the Brooklyn Edison Company was as test engineer in 1923.

V. M. GRAHAM (A'23, M'29) radio engineer for the Stromberg-Carlson Telephone Manufacturing Company, at Rochester, N. Y., recently was appointed chairman of the standards section of the Radio Manufacturers Association of New York, N. Y.

EDWARD ALLEN (A'30) field engineer for the Public Service Company of Northern Illinois, has been transferred from the Maywood (Ill.) territory to Harvey, Ill., were he will continue in the capacity of field engineer.

WILLIAM ARTHUR (A'12, M'17) previously located in New York, N. Y., as assistant to vice-president, American Brown Boveri Company, now should be addressed in care of Allis-Chalmers Manufacturing Company, New York, N. Y.

W. H. HARRISON (A'20, M'30) plant engineer for the American Telegraph and Telephone Company, New York, N. Y., at a recent election was chosen to serve on the executive committee of the A.I.E.E. New York Section.

F. A. LAVIGNE (A'26) who for many years has been local manager of the Associated Wholesale Electric Company at Los Angeles, Calif., now has associated himself with The Electric Material Company, Inc., of San Francisco.

S. A. SMITH, JR. (A'24) assistant transmission engineer for the Public Service Electric and Gas Company, Newark, New Jersey, has been made chairman of the power group of the Institute's New York Section for 1932–1933.

I. S. COGGESHALL (A'30) general traffic supervisor of the Western Union Telegraph Company, New York, N. Y., recently was elected to the chairmanship of the communication group of the Institute's New York Section for 1932–1933.

W. T. BLACKWELL (A'22) general lighting representative of the Public Service Electric and Gas Company, Newark, N. J., has received reelection as chairman of the illumination group of the Institute's New York Section for 1932–1933.

H. C. DEAN (A'12, F'30) general superintendent of the New York and Queens Electric Light and Power Company, Flushing, N. Y., has been elected to serve for 1932–1933 on the executive committee of the Institute's New York Section.

J. D. CARROLL (A'21) formerly assistant engineer of the Electric Bond and Share Company, New York, N. Y., now is serving the Public Service Commission of Maryland, at Baltimore, in like capacity.

R. W. STONE (A'32) of the sales department of the Oswego Motor Car Company, Oswego, N. Y., shares with D. C. ROBINSON (A'32) the North Eastern District prize for the Branch paper for 1931. Oswego is Mr. Stone's native city. He received his B.S. in E.E. from Syracuse University with the class of 1931, and the summer between his junior and senior years worked for the

R. W. STONE

American Telephone and Telegraph Company, New York, N. Y., in the transmission engineering department, where his work consisted chiefly of becoming acquainted with the various phases of telephone work in connection with carrier telephone systems and central offices, radio program transmission, and telephone plant maintenance.

J. R. BATCHELLER (Enrolled Student) Oregon State Agricultural College at Corvallis, Ore., has been awarded the Institute's North West District prize for Branch paper presented during 1931. The award was made for Mr. Batcheller's

J. R. BATCHELLER

paper, "Abridged Method of Testing Welds," presented at a joint meeting of the Oregon State College Branch and the A.I.E.E. Portland, Ore., Section, May 23, 1931. The author is a native of Portland and is continuing his studies at the Oregon State college, where he took a course in electrical engineering and from which he was graduated in 1931 with his B.S. degree.

G. R. DITTWE (A'26) until recently sales engineer for the Garland-Affolter Engineering Corporation at Los Angeles, Calif., is now manager of Electric Agencies at Oakland, Calif.

J. E. WOODS ('30) assistant chief engineer of the Central Power and Light Company, San Antonio, Texas, as of April 14, 1932, was transferred to Guero, Texas, where he continues to serve the company.

C. O. EVANS (A'22) who has been serving the British American Metals Company of New York, N. Y., as secretary, now is secretary of the British-American Tube Company, New York, N. Y.

W. P. HAMMOND (M'20) formerly engineer of generating plants, Allied Engineers, Incorporated, Birmingham, Ala., now has become general engineer of the Georgia Power Company at Atlanta, Ga.

T. F. BARTON (A'12, F'30) district engineer for the General Electric Company, New York, N. Y., is the new chairman of the New York Section of the Institute, to hold office during the fiscal year 1932–1933.

W. R. SMITH (M'18, F'30) assistant chief engineer, United Engineers and Constructors, Inc., Newark, N. J., has been elected secretary of the Institute's New York Section for 1932–1933.

L. L. EDGAR (A'12) vice-president in charge of the operating bureau of the Edison Electric Illuminating Company of

Boston has succeeded his father in the office of regional director for New England of the refrigeration bureau of the National Electric Light Association.

Obituary

BENSON OSBORN ELLIS (M'23) operating manager of the Cia Anglo Argentina de Electricidad, S. A., died there of cerebral hemorrhage, October 1931, according to information received recently. He was born in Corina, Maine, September 24, 1873, and was a graduate of the high school at Dexter, Maine. In 1890 he engaged with the Brunswick Electric Light and Power Company, Brunswick, Maine, as station operator, having worked previously on inside wiring and line construction. Three years later he joined the Knox Gas and Electric Company and the Rockland, Thomaston and Camden Street Railway Company, Rockland, Maine, as construction foreman in charge of overhead work, inside wiring, customers' installations, and also operation of the power plant. In this position he remained for four years, after which he went to Astoria, N. Y., in 1897, where he became electrical superintendent in charge of power plant operation, overhead line construction, and customers' installations for the Astoria Electric Light and Power Company. Later he was associated with William Sheehan and Company, contracting engineers, New York City, in charge of the design and construction of small central station installations. In 1906 he became construction superintendent of the J. G. White & Company, Inc., taking over the general charge of new power plant and substation construction, high voltage transmission, and street railway extensions and repair for the Eastern Pennsylvania Railway Company, Pottsville, Pa. His next change came in 1908 when he went with the Columbia Power, Light and Railways Company as general manager in charge of rehabilitation and operation of street railway, and gas and electric light properties, in Berwick, Bloomsburg, and Danville, Pa. In 1910 he returned to the J. G. White organization and was active on many important projects. He was placed in charge of powerhouse extension, substation, and underground work and the rebuilding of street railway lines for the Wilmington and Philadelphia Traction Company, Wilmington, Del.; in 1912 he was sent to take charge of powerhouse and substation construction, transmission line erection, and low voltage distribution for an electric company in Venezuela; and in 1914 he was sent to take charge of the building of the street railway system for the Quito Tramways Company, Quito-Ecuador, S. A. The last named connection led to his appointment as general manager and chief engineer of the Quito Tramways Company and the Quito Electric Light and Power Company. In 1923 he returned to the United States and established an electrical engineering and construction business of his own in New York City. In this he continued until he went to Cuba to take charge of electrical engineering and construction for the Cuban Electric Company at Havana. The year 1927 found him division manager of the Florida Power and Light Company, at Sarasota, Fla., the position which he left when he was made assistant to the president of the Public Utilities Consolidated Corporation, at Minneapolis, Minn., in 1929. Immediately prior to his last position in Argentina, he was president of the Central American Power Corporation at Nicaragua.

HENRY E. MCGOWAN (M'17), secretary of the Brooklyn (N. Y.) Union Gas Company, died at the Long Island College Hospital, Brooklyn, N. Y., May 7, 1932. He had been with that company for 24 years. Mr. McGowan was a native of Brooklyn; his early education was obtained at private schools and included five years of military training. In 1889 he went to the Stevens Institute preparatory school and in 1894 was graduated from Stevens Institute with a degree in mechanical engineering. For the next three years he was process chemist for Church and Company, Trenton, Mich., a concern manufacturing soda by a special ammonia process. In this connection, Mr. McGowan first served a term in the company's laboratory immediately under the chief chemist and in complete charge of process of production. In 1898 he went with the Brooklyn Union Gas Company as electrical engineer, his chief duties being to investigate the matter of electrolytic damage to sub-surface plant, and to follow up prospects for gas-engine-driven electric installations. In addition to these duties, in 1903 he was elected general manager of the Flatbush Gas Company. This company was a subsidiary of the Brooklyn Union Gas Company, but carried on an electric power business in addition to its gas distribution activities. In this affiliation all extensions of electric station and distribution equipment were carried out directly under Mr. McGowan's supervision and direction, including the purchasing of all turbo-generators, boilers, condensers, and other necessary equipment, and the prescribing of the systems and designs to be employed. In 1914 he was made assistant secretary of the Brooklyn Union Gas Company, at the same time holding like office in five of its subsidiaries, and in addition retaining the title of general manager at the Flatbush Gas Company. Mr. McGowan has contributed two articles to technical literature: "Electrolysis, the Effect of Stray Trolley Currents," published in the *Stevens Indicator*, and a "Remedy for Electrolytic Damage to Mains," published in *Progressive Age*. He was a member of the National Electric Light Association, the Brooklyn Chamber of Commerce, the American Gas Association, and The American Society of Mechanical Engineers. He held membership also in the Crescent Athletic-Hamilton Club.

CARL LEO MEES (A'03) president emeritus of Rose Polytechnic Institute, Terre Haute, Ind., and prominent as a scientist and medical authority, died at Terre Haute, April 19, 1932. He was born at Columbus, Ohio, May 20, 1853, and in due course of time became a student at Ohio State University. This schooling was amplified by a course at the University of Berlin, Germany, with study under the eminent physicists, Hermann Helmholtz and Gustav Kirchhoff. In further pursuit of knowledge, he went to South Kensington, England; then, returning to the United States and his native city, he entered the Starling Medical College at Columbus, Ohio, but never practised medicine. In 1871 as chief chemist he was with the Ohio geological survey and state gas commission, and four years later became professor of physics and chemistry at the University of Louisville, Ky. From 1881 to 1887 he was professor of chemistry and physics of the newly organized Ohio University at Athens, Ohio, later in 1887 assuming his professorship at Rose Polytechnic Institute as teacher of physics and electricity. His presidency there extended over the period from 1895 to 1919, when he resigned the active presidency and became president emeritus. Perhaps the best known of Doctor Mees's achievements was the development of a process making possible microscopic photographs of human blood and minute tissues. This process was adopted by the Army and Navy research departments, and was employed nationally in the detection and solution of crime. He was a Fellow of the American Association for the Advancement of Science, of which he was also general secretary in 1889 and a vice-president in 1896; his other memberships included the American Physical Society, the Society for the Promotion of Engineering Education, and the Indiana Academy of Science. He was also an honorary member of the State Credit Men's Association. Doctor Mees was the author of many scientific papers and contributions to technical literature.

HARRY N. VAN DEUSEN (A'19, M'30), materials engineer for the Bell Telephone Laboratories, Inc., New York, N. Y., died suddenly May 15, 1932, at the Easton Hospital, Easton, Pa. He was born at Columbia, N. J., December 3, 1884, and was graduated from Purdue University, Lafayette, Ind., in 1907 with the degree of B.S. in E.E. In June 1907 he engaged with the maintenance department of the Chicago Telephone Company (Ill.), where he gained a varied experience in central office testing, outside testing and installation, and inspection of central office equipment. March 1909 he returned to the University of Purdue as professor of machine design, remaining in this teaching capacity until the end of the school term. He then became equipment engineer of the Western Electric Company, at Hawthorne, Ill., and continued there until 1912, when he was transferred to the engineering department of the Company in New York. In 1925 he became a member of the technical staff of the Bell Telephone Laboratories, Inc., and was at the time of his death one of its workers in the analytical study of magnetic materials, insulating materials, protection apparatus and the analysis and testing of

all types of telephone apparatus. A resident of East Orange, N. J., for the past twenty years, he was chairman of the insulating materials committee of the American Society for Testing Materials, a member of the New York Electrical Society, and was the Bell Telephone Laboratories' representative in the American Welding Society.

WILLIAM H. HILL (A'04) superintendent of electrical construction for the New York Edison Company, and an employee of that company for 42 years, died May 4, 1932, after a short illness. He was 66 years of age. Born in Philadelphia, Pa., Mr. Hill started his electrical career, in 1888, as a splicer's helper with the Philadelphia Edision Company. Approximately ten years later he became a splicer for the Toronto Edison Company. The following year he returned to the United States and engaged with the New York Edison Company, then the Edison Electric Illuminating Company, still as a splicer of cables. From then on his promotion was rapid; in 1902 he was made foreman, a year later being advanced to general foreman, the next year to assistant superintendent of electrical construction, and shortly thereafter to the office he last held, superintendent of electrical construction. His effort with the New York Edison Company was not restricted to purely departmental activities, for it was through his instrumentality that the Edison Company's Employees' Association was founded, Mr. Hill being placed in the presidency of that organization. He was a member of the Edison Pioneers.

LOUIS GEORGE FREEMAN (A'16) for more than twenty years in charge of the lighting, power, and signal systems, and the design and installation of simple laboratory apparatus for the U. S. Geological Survey, Washington, D. C., died December 8, 1931, according to word recently forwarded to Institute headquarters. Mr. Freeman was born at Washington, D. C., January 27, 1869, and after public schooling, spent three years at George Washington University, Washington, D. C.

Local Meetings

Student Convention Held in New York

A highly successful student convention was held on April 29, 1932, at Institute headquarters by the several Branches within the territory of the Institute's New York Section. Eight Branches participated as follows: Brooklyn Polytechnic Institute, Cooper Union, Newark College of Engineering, College of the City of New York, New York University, Pratt Institute, Rutgers University, and Stevens Institute of Technology.

The morning session was devoted to inspection trips to various nearby points of interest. During the afternoon session, a talk on "Photofilms" was given by Dr. Johnson O'Connor (A'22) of Stevens Institute, after which a dinner was held at the Hotel McAlpin. A joint student meeting and general Section meeting was held during the evening.

The first portion of the evening program was devoted to the presentation of three student papers entered in competition for the New York Section student-paper prizes. The first prize of $25 went to Russell Buehl of Brooklyn Polytechnic Institute for his paper "Frequency Control by Means of the Thyratron Tube"; second prize of $10 to E. Olsta of Newark College of Engineering, for his paper "Carrier Current Communication as a Factor in the Stability of Power Systems." The awards were made by a group of prominent New York Section engineers.

During the second portion of the evening session, Dr. Frank B. Jewett (F'12 and past-president), vice-president, American Telephone and Telegraph Company, New York, gave a talk on "What the World Expects of the Electrical Engineer." "Graduates of the present period," said Doctor Jewett, "do not find before them the rosy outlook enjoyed by graduates of a few of the preceding years. Nevertheless on the basis of my own life-work I believe that a hard path at the start of a professional career is of tremendous value as a character builder and developer of the best traits."

Later in his address Doctor Jewett declared: "The past 50 years' work has been *creative;* now we have entered into a period which has an objective slightly different from that of the period just passed. There have been so many developments, and they have been prosecuted so individually that now more than ever the problem of coordination looms up as of prime importance not only within the technical field of the electrical engineer, but also in the relation of that field to every-day life. Coordination inevitably will be the, or one of the, most compelling problems challenging the electrical engineer in the future."

METHOD OF JUDGING STUDENT PAPERS

Because of the success of the method used by the committee in judging the papers, a brief outline of this method is presented herewith in the belief that it may be of some value to other committees facing similar problems. Each Branch was allowed to submit one paper for the competition; the written papers then were rated independently by three judges on the basis of the following points:

Grasp of subject	10 points
Arrangement of material	10 points
Constructive character of ideas	10 points

The three papers receiving the highest number of points in this first rating were selected for presentation at the convention, where the judges of the oral presentation rated them on the following basis:

Clarity	10 points
Force of expression	10 points
General platform decorum	10 points

All Branches participating in the contest were informed in advance regarding details of the plan to be used; thus all contestants knew beforehand upon just what basis their papers would be judged. This common understanding, together with the fact that the judges were given definite points upon which to rate the papers are believed to be the two principal features contributing most toward the workability of the plan. The practicability and success of the system was demonstrated by the close agreement reached by the judges, all of whom worked individually.

Schenectady and Pittsfield Sections Hold Competition

Following the plan inaugurated three years ago to encourage their younger members to participate in programs, the Schenectady and Pittsfield Sections held joint meetings in Schenectady, April 7, 1932, and Pittsfield, April 13, 1932, for the presentation of papers by section members less than 30 years of age, who had not previously presented Institute papers. The programs were as follows:

Schenectady

PROTECTION OF UNDERGROUND STRUCTURES FROM CORROSION, by F. K. Fox, Pittsfield.
CALCULATION OF TWO MACHINE STABILITY WITH RESISTANCE, by S. R. Pritchard, Schenectady.
THE BLOWING OF FUSES BY IMPULSE, by T. Brownlee, Pittsfield.
INCREASING STABILITY LIMIT OF GENERATORS, by S. B. Crary, Schenectady.
ELECTRICAL MUSIC, by A. H. Foley, Pittsfield.
X-RAY AND CATHODE RAY TUBES IN THE PRODUCTION OF NEW FORMS OF LIFE, by C. P. Haskins, Schenectady.

Pittsfield

VOLTAGE DROP CALCULATIONS FOR LONG TRANSMISSION LINES, by R. N. Slinger, Schenectady.
MEASUREMENT OF CURRENT IN IMPULSE CIRCUITS WITH THE CATHODE RAY OSCILLOGRAPH, by S. W. Zimmerman, Pittsfield.
DESIGN OF TYPE D CARRIER TELEPHONE FACILITIES, by S. B. Benson, Schenectady.
LIGHTNING INVESTIGATION ON TRANSMISSION LINES, by H. E. Pierce, Pittsfield.
STARTLING STARTS AND STOPS—UNUSUAL SYNCHRONOUS MOTOR PERFORMANCE, by C. E. Kilbourne, Schenectady.
THYRATRON COMMUTATED MOTOR, by G. B. Nonken, Pittsfield.

Prizes were awarded after consideration of the contents of the papers as well as the presentation. At the Schenectady meeting, C. P. Haskins of Schenectady received the first prize, and S. R. Pritchard of Schenectady received second prize. The attendance was 250.

At the Pittsfield meeting, C. E. Kilbourne of Schenectady received the first prize and R. V. Slinger of Schenectady received the second prize. The combined prize, the F. W. Peek, Jr., cup, went to the Schenectady Section who are permanent holders since they won it two out of three years. The attendance was 175.

Future Section Meetings

Detroit-Ann Arbor. June 21—spring frolic.

Louisville. June 3—Outdoor recreation meeting. Annual election of officers.

Vancouver. June 6—Annual dinner.

Past Section Meetings

Akron

Inspection trip to the Ohio Edison Company's East Akron substation. THE LOAD SHIFTING TRANSFORMERS AT SALT SPRINGS, by J. H. Foote and L. N. Gozinski. Feb. 9. Att. 45.

ELECTRIC REFRIGERATION AND AIR CONDITIONING, by W. M. Timmerman, Genl. Elec. Co.

THE ELECTRICAL INDUSTRY AND SOME PROBLEMS OF THE INSTITUTE, by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg. Co. April 12.

Atlanta

C. H. Dolan, Eastern Air Transport, and C. R. Whittaker, vice-consul, Foochow, China, gave talks on the Sino-Japanese situation. Joint meeting with A.S.M.E. Sec. March 21. Att. 75.

Baltimore

MATERIAL HANDLING, by H. V. Schmidt; ELECTRICAL DISTRIBUTION SYSTEM, POINT BREEZE WORKS, by W. A. Halliday; POWER HOUSE, POINT BREEZE WORKS, by E. F. George; all of the Western Elec. Co. Films—"New Voice Highways" and "Modern Knight." Joint meeting with A.S.M.E. Dinner. April 14. Att. 180.

Boston

A GENERAL DESCRIPTION OF THE LACKAWANNA ELECTRIFICATION, by E. L. Moreland, Jackson & Moreland. Film—"On the Pathways of Progress." April 21. Att. 105.

Chicago

DESIGN AND OPERATION OF OVERHEAD LINES IN RELATION TO CONTINUITY OF SERVICE, by F. E. Andrews, Pub. Serv. Co. of No. Ill. March 17. Att. 115.

RATES AND RATE MAKING, by F. E. Kruesi, Middle West Utilities Co. April 14. Att. 95.

DEVELOPMENT OF THE USE OF ELECTRICITY IN STEEL MILLS, by C. J. Smith, Ill. Steel Co. Election of officers: L. R. Mapes, chmn.; B. C. Williams, vice-chmn.; D. L. Smith, secy.-treas. Joint meeting with Western Soc. of Engrs. May 2. Att. 134.

Cleveland

ELECTRIC REFRIGERATION AND DOMESTIC AIR CONDITIONING, by W. M. Timmerman, Genl. Elec. Co. Illus. April 21. Att. 56.

Columbus

A-C. NETWORKS, by F. W. Marquette, Columbia Ry. Pwr. & Lt. Co. Jan. 8. Att. 36.

RECENT TELEPHONE RESEARCH AND ITS APPLICATION, by S. P. Grace, asst. vice-pres., Bell Tel. Labs., Inc. Joint meeting with the A.S.M.E., A.S.C.E., Engrs.' Club, and Electric League of Columbus. Jan. 22. Att. 3485.

GEORGE WASHINGTON, ENGINEER, BUSINESS MAN, AND STATESMAN, by C. T. Marshall, Chief Justice Supreme Court, State of Ohio. Joint meeting with A.S.C.E., A.S.M.E., Engrs.' Club, in cooperation with George Washington Bicentennial Committee. Feb. 26.

ELECTRIC SHOCK, by Dr. W. B. Kouwenhoven, Johns Hopkins Univ., vice-pres. A.I.E.E. Joint meeting with Ohio State Univ. Branch. Dinner. April 22. Att. 44.

Connecticut

MOULDED PLASTICS, by F. J. Groten, Genl. Elec. Co. Feb. 16. Att. 65.

Dallas

THE COORDINATION OF LINE AND STATION DESIGN FOR LIGHTING SURGE CONDITIONS, by A. O. Austin, Ohio Brass Co. April 11. Att. 81.

Denver

RURAL ELECTRIFICATION, by C. A. Lory, Colorado Agri. Col. Dinner. April 15. Att. 70.

Detroit-Ann Arbor

COMMERCIAL METERING OF ELECTRIC ENERGY, by A. S. Albright, Detroit Edison Co. April 19. Att. 150.

Florida

Business meeting in Jacksonville, April 14, during spring meeting of Florida Engg. Soc., April 14-16. Reports by secretary and chairmen of membership and student activities committees. Appointment of nominating committee. Joint dinner on evening of April 14 of Florida Engg. Soc., and A.S.C.E., A.S.M.E., and A.I.E.E. Sections and Branches, Att. 20.

Fort Wayne

REACTANCE IN TRANSFORMER DESIGN, by J. F. Bitman, Genl. Elec. Co.; TRANSFORMERS WITH PEAKED SECONDARY VOLTAGE WAVE, by O. Kiltie, Genl. Elec. Co. Demonstrations. April 14. Att. 40.

Houston

COORDINATION OF LINE AND STATION DESIGN FOR LIGHTING SURGE CONDITIONS, by A. O. Austin, Ohio Insulator Co. April 15. Att. 28.

Indianapolis-Lafayette

THE ELECTRICAL INDUSTRY OF TODAY, by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg. Co. Dinner. March 31. Att. 95.

THE CORPUSCULAR THEORY OF LIGHT, THE WAVE THEORY OF MATTER, THE NEW PHYSICS, by Prof. C. T. Knipp, Univ. of Ill. Joint meeting with Purdue Univ. Branch. April 26. Att. 205.

Ithaca

HIGH SPOTS IN THE DESIGN OF STEAM ELECTRIC POWER PLANTS, by I. E. Moultrop, vice-pres., A.I.E.E., Chief Engr., Edison Elec. Ill. Co. of Boston. March 9. Att. 50.

Kansas City

GENERAL FEATURES OF TELEGRAPH SERVICE AS USED IN THE BELL TELEPHONE SYSTEM, by B. A. Kahn, Southwestern Bell Tel. Co. April 18. Att. 48.

ADVENTURERS IN SCIENCE, by E. L. Manning, Genl. Elec. Co. Meeting held in cooperation with the engineering societies of Kansas City, under the auspices of the Electric and Radio Assn. April 21. Att. 875.

Lehigh Valley

POWER SYSTEM OPERATION, by G. M. Keenan, Pa.-N. J. 220 Kv. Interconnection. Inspection trip through the Metropolitan Edison Co. Nov. 13, 1931. Att. 124.

ELECTRICAL POWER IN THE ANTHRACITE FIELDS AND ITS APPLICATION TO COAL MINING, by W. H. Lesser, Penn Anthracite Mining Co. Inspection trip through the new Locust Summit central breaker of the Phila. and Reading Coal & Iron Co. Dec. 11, 1931. Att. 122.

PRIMARY NETWORK DISTRIBUTION SYSTEMS, by D. K. Blake, Genl. Elec. Co. Jan. 15. Att. 176.

RESEARCH—INDUSTRY'S HEALTH INSURANCE, by S. M. Kintner, Westinghouse Elec. & Mfg. Co. Joint meeting with the Engrs.' Club. March 18. Att. 122.

Los Angeles

RADIO INTERFERENCE, by Prof. J. K. McNeely, Calif. Inst. of Tech. Dinner. April 12. Att. 86.

Louisville

FUNDAMENTALS OF PLANT CONSTRUCTION AND PLIGHT, by A. W. Lee, Louisville Gas & Elec. Co. Inspection trip through the Bowman Field airport. April 15. Att. 450.

Lynn

WHAT ARE YOU AFRAID OF? by Dr. Charles Newcomb. Banquet. April 9. Att. 194.

Madison

PROSPECTING IN SCIENCE, by M. W. Hanks, Hankscraft Co. Dinner. April 20. Att. 65.

Memphis

DREDGING OPERATIONS FROM THE TIME OF THE CIVIL WAR UP TO THE PRESENT DATE, by Major H. S. Gladfelter. April 12. Att. 33.

Mexico

THERMODYNAMIC CONSIDERATIONS ON THE MODERN STEAM TURBINE, by G. A. Schulenburg, A. E. G. Co. Dinner. March 17. Att. 28.

J. Herandez Olmedo described the organization and systems used by the National Telegraphs. Illus. Dinner. April 14. Att. 31.

Milwaukee

TELEVISION, by Sam Snead, Univ. of Wis. Joint meeting with the Engrs. Soc. of Milwaukee. Dinner. March 23. Att. 450.

Minnesota

Demonstration and lecture by S. P. Grace, asst. vice-pres. Bell Tel. Labs., Inc. Joint meeting with the Univ. of Minn. Branch. April 14. Att. 5000.

Montana

LIGHT AND ILLUMINATION, by Prof. J. A. Thaler and Prof. F. C. Bowman, Mont. State Col. Joint meeting with Montana Soc. of Engrs. April 11. Att. 60.

Nebraska

LIGHTING AND ITS RELATION TO ELECTRIC APPARATUS, by Dr. C. L. Fortescue, Westinghouse Elec. & Mfg. Co. Dinner. March 18. Att. 80.

New York

RECENT DEVELOPMENTS IN RADIO BROADCASTING, by R. L. Davis, Westinghouse Elec. & Mfg. Co., and E. W. Wallace, Am. Tel. & Tel. Co. March 15. Att. 300.

REGULATION OF POWER FLOW BETWEEN INTERCONNECTED SYSTEMS, by H. L. Melvin, Elec. Bond & Share Co., and J. B. McClure, Genl. Elec. Co. April 15. Att. 325.

ELECTRIC LOCOMOTIVES ON THE PENNSYLVANIA, by J. V. B. Duer, Penn. R.R. April 19. Att. 425.

Niagara Frontier

Nominating committee meeting. March 28.

SURGE PROOF POWER TRANSFORMERS, by H. V. Putman, Westinghouse Elec. & Mfg. Co. Illus. Election of officers: F. S. Wahl, chmn.; J. F. Oehler, secy.-treas. Dinner. April 15. Att. 90.

North Carolina

Spring meeting opened with address of welcome by Mr. House, Univ. of No. Carolina. VALUATION FOR RATE MAKING, by R. O. Self, No. Carolina Corp. Comm.; ARC WELDING AS APPLIED TO MANUFACTURING PROCESSES, COVERING BOTH MACHINERY AND BUILDINGS, by C. I. MacGuffie, Genl. Elec. Co.; SURGE PROOF DISTRIBUTION TRANSFORMERS, by H. D. West, Westinghouse Elec. & Mfg. Co.; ILLUMINATION FOR THE FUTURE, by R. A. Palmer, Southern Pub. Utilities Co. Illus. Short talk by W. S. Lee, past-pres., A.I.E.E., pres. W. S. Lee Engg. Corp. Dinner. April 5. Att. 180.

Oklahoma City

VERTICAL TRANSPORTATION, by R. W. Van Kirk, Genl. Elec. Co. Discussion. March 21. Att. 60.

THE COORDINATION OF LINE AND STATION DESIGN FOR LIGHTNING SURGE CONDITIONS, by A. O. Austin, Ohio Insulator Co. Dinner. April 21. Att. 90.

ADVENTURES IN SCIENCE, by E. L. Manning, Genl. Elec. Co. Demonstrations. April 25. Att. 1430.

Philadelphia

THE ENGINEER'S PROFESSIONAL STATUS, by Dr. W. E. Wickenden, Case Sch. of Ap. Sc. March 14. Att. 210.

THE INSTITUTE AND THE ELECTRICAL INDUSTRY—WHAT OF THEIR FUTURE? by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg Co.; PUBLIC INTEREST IN SCIENCE, by Fred F. Shedd, managing editor, *Phila. Evening Bulletin*. April 11. Att. 160.

Pittsburgh

THE ELECTRICAL INDUSTRY OF TODAY, by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg. Co.; HOW TO INTEREST THE PUBLIC IN ENGINEERING NEWS, by Mark Shields, *Pittsburgh Sun-Telegraph*; RAMBLING WITH REICHHOLD, by Ralph Reichhold, Pittsburgh Press artist; ELECTRIFYING A SPECIALTY, by Dr. Charles Wales. Joint meeting with the Engrs. Soc. of Western Penn., and Carnegie

Inst. of Tech., Univ. of Pittsburgh, and Univ. of West Virginia Branches. Jan. 12. Att. 340.

PITTSBURGH'S CONTRIBUTION TO RADIO DEVELOPMENT, by S. M. Kintner, Westinghouse Elec. & Mfg. Co. Joint meeting with Engr. Soc. of Western Penn., held in connection with the annual convention of the I.R.E. April 7. Att. 500.

Pittsfield

THE SCIENCE AND THEORY OF MAGNETISM, by Dr. S. R. Williams, Amherst Col. E. G. Newton received a prize for presenting the best paper before the Section during 1931. Dinner. April 22. Att. 110.

Portland

SURGE-PROOF TRANSFORMERS, by A. W. Copley, Westinghouse Elec. & Mfg. Co., vice-pres. A.I.E.E. April 12. Att. 52.

Providence

COMMUNICATION SYSTEMS WHICH COMPROMISE THE INTERNATIONAL TEL. & TEL. NETWORK, by A. A. Closkey, Intl. Tel. & Tel. Co. Demonstrations. April 20. Att. 200.

Rochester

PROGRAM SERVICE SYSTEMS, by A. E. Soderholm. Jan. 14. Att. 69.

HOW A MODERN RADIO STATION FUNCTIONS, by Wm. Fay, Stromberg-Carlson Mfg. Co. Joint meeting with the I.R.E. Feb. 11. Att. 319.

MODERN MANUAL TELEPHONE PRACTISE, by Mr. Vincent and Mr. Gillespie, Rochester Tel. Corp. March 3. Att. 94.

CHANGES IN METHODS OF INDUSTRIAL DEVELOPMENT AS A RESULT OF INDUSTRIAL RESEARCH, by Dr. F. B. Jewett, vice-pres., Am. Tel. & Tel. Co., and pres. Bell Tel. Labs., Inc. Demonstrations by Mr. L. S. O'Roark, Bell Tel. Labs., Inc. March 28. Att. 400.

THE APPLICATION OF ENGINEERING PRINCIPLES TO THE PRODUCTION OF ARTIFICIAL FEVER, by Dr. Stafford L. Warren. Joint meeting with the I.R.E. April 7. Att. 133.

St. Louis

HEATING AND OVERLOAD PROTECTION OF POLYPHASE MOTORS, by C. P. Potter, Wagner Elec. Corp. Election of officers: F. B. Wipperman, chmn.; Ralph Kelley, vice-chmn.; S. L. Hilyard, secy. April 20. Att. 85.

San Antonio

THE COORDINATION OF LINE AND STATION DESIGN FOR LIGHTNING SURGE CONDITIONS, by A. O. Austin, Ohio Insulator Co. Illus. Dinner. April 18. Att. 110.

San Francisco

THE PRECISE ELECTRICAL MEASUREMENT OF SHORT-TIME INTERVALS, by Wm. McLeod, Univ. of Calif.; INFLUENCE OF CONDUCTOR TEMPERATURE ON CORONA LOSS, by A. K. Nuttall, Stanford Univ.; THE APPLICATION OF THE INVERTED VACUUM TUBE TO THE MEASUREMENT OF VOLTAGES, by L. W. Thorpe and R. Sheridan, Univ. of Santa Clara. Joint meeting with the Univ. of Calif., Stanford Univ., and Univ. of Santa Clara Branches. First prize of one year's dues in the Institute was awarded to L. W. Thorpe, Univ. of Santa Clara. April 15. Att. 48.

Saskatchewan

LOOP SYSTEMS IN H. T. TRANSMISSION FOR URBAN DISTRICTS, by N. W. Dubois, Dominion Elec. Pwr., Ltd., and E. W. Bull, supt. of light and power of Regina. Feb. 5. Att. 31.

Ladies' Night. April 22. Att. 52.

Schenectady

Seven members of the staff of the Genl. Elec. Co. spoke on the subject of noise measurement and reduction. Joint meeting with the A.S.M.E. Sec. March 3. Att. 225.

THE LOCOMOTIVES OF THE FUTURE, by A. Lipetz, Am. Locomotive Co. Joint meeting with A.S.M.E. Sec. March 24. Att. 200.

Seattle

Joint meeting with the Univ. of Wash. Branch, at which the following papers were presented by students: MEASUREMENT OF HARMONICS BY MEANS OF VACUUM TUBES, by R. M. Boyle; MAGNETIZATION CURVE BY MAGNETIC PULL METHOD, by M. Bouck; VELOCITY ASPECTS OF THE ELECTRIC FIGURES, by Arthur Kramer. April 19. Att. 80.

Sharon

A PERSONAL TOUR OF EUROPEAN POWER STATIONS, by Philip Sporn, Am. Gas & Elec. Co. Film—"Behind the Lines." April 12. Att. 125.

Springfield

THE EARTH, A GREAT MAGNET, by Prof. S. Williams, Amherst Col. March 14. Att. 81.

ARTIFICIALLY GENERATED SUNLIGHT, by Dr. Paul Luckenbach, Genl. Elec. Co. Election of officers: Hans Passburg, chmn.; L. C. Packer, vice-chmn.; J. J. Finn, secy.-treas. April 11. Att. 54.

Toronto

NEW UTILITY GIVEN MERCURY ARC RECTIFIERS BY SECTIONALIZING, by A. L. Atherton, Westinghouse Elec. & Mfg. Co. Joint meeting with Engineering Inst. of Canada. April 22. Att. 300.

A TRIP THROUGH THE CANADIAN ARCTIC, by Lawren Harris. Illustrated. Election of officers: I. M. Maclean, chmn.; J. M. Thomson, secy.-treas. April 29. Att. 100.

Urbana

THE INSTITUTE AND THE ELECTRICAL INDUSTRY—WHAT OF THEIR FUTURE? by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg. Co. Joint meeting with Purdue Univ. and Rose Poly. Inst. Branches. April 2. Att. 166.

Utah

THE PUBLIC UTILITY, by G. M. Gadsby, Utah Pwr. & Lt. Co. Dinner. March 7. Att. 37.

THE DEVELOPMENT OF UTAH, by A. B. Young. March 30. Att. 45.

Vancouver

PROTECTIVE SWITCHGEAR FOR A-C. POWER SYSTEMS, by D. Robertson, Can. Genl. Elec. Co. Illus. April 4. Att. 55.

THE MERCURY ARC RECTIFIER, by L. M. Morton, Genl. Elec. Co. April 25. Att. 50.

Worcester

ELECTRIC HEATING INDUSTRY, by H. M. Chatto, Genl. Elec. Co. Feb. 29. Att. 38.

TRAMWAYS, by E. T. Reardon, Am. Steel & Wire Co. March 17. Att. 20.

RECENT DEVELOPMENT IN THE APPLICATION OF ELECTRIC MOTOR DRIVES IN THE PAPER, TEXTILE, AND MACHINE TOOL INDUSTRIES, by H. F. Banan and F. D. Snyder, Westinghouse Elec. & Mfg. Co. Dinner. April 14. Att. 60.

Past Branch Meetings

University of Akron

THE PROGRESS OF RADIO, by John Chenot, student; REFRIGERATION, by R. A. Gerber, student. Dec. 9, 1931. Att. 15.

THE ZEPPELIN AKRON, by J. C. Fessler, student; SOME APPLICATIONS OF THE PHOTOELECTRIC CELL, by Sol. Leiboritz, student. Demonstrations. March 9. Att. 11.

Prof. J. T. Walther, counselor, outlined the activities of the A.I.E.E. Frank Marcinkoski, chmn., reported on the student convention held at Haverford Col. April 22. Att. 10.

Alabama Polytechnic Institute

ORNAMENTAL FORESTRY, by Mr. Evans, Alabama Pwr. Co. April 14. Att. 19.

THE VALUE OF BELONGING TO THE A.I.E.E., by Prof. W. W. Hill, counselor. April 21. Att. 10.

MUSCLE SHOALS, by R. Roberts. April 28. Att. 7.

Entertainment. May 5. Att. 42.

University of Alabama

Business meeting. April 11. Att. 24.

PRINCIPLE OF UNCERTAINTY, by Dr. B. A. Wooten. Election of officers: W. R. Purcell, chmn.; John Marshall, vice-pres.; E. L. Appoloni, secy.; J. Del Coliano, treas. April 25. Att. 45.

University of Arizona

THE RECORDING OF SOUND FOR SOUND PICTURES, by J. W. Jones, student. April 1. Att. 9.

THE REPRODUCTION OF SOUND IN SOUND PICTURES, by H. E. Stewart, student. April 8. Att. 7.

SPEED CONTROL BY ELECTRON TUBES OF SOUND PICTURE PROJECTORS, by R. H. Carson, student; SOME RECENT EXPERIMENTS IN ELECTRON PHYSICS, by Dr. E. H. Warner. Dinner. April 15. Att. 7.

University of Arkansas

ELECTRICAL DISTRIBUTION, by H. H. Lewis, student; WELDING GENERATORS, by L. F. Williams, student. Election of officers: L. C. Wasson, chmn.; R. B. Stone, vice-chmn.; C. L. Mowery, secy.; P. H. Johnson, treas. April 11. Att. 24.

Bucknell University

Discussion. March 21. Att. 10.

ALL ELECTRIC SHIP, by John Barton, student. H. Smithgall, Jr., elected secy.-treas., and J. A. Everitt, elected vice-pres. April 18. Att. 18.

MODULATION MEASUREMENTS BY OSCILLOGRAPH ON RADIO STATION WPSC, by D. H. Smith and R. F. Carlson, Penn. State Col.; GRAPHICAL SOLUTIONS OF ALTERNATING CURRENTS, by James Dobbie, Bucknell Univ. Joint meeting with Penn. State Col. April 27. Att. 49.

California Institute of Technology

SOME RECENT DEVELOPMENTS IN TELEPHONE COMMUNICATION, by C. A. Wells, Southern Calif. Edison Co., Ltd. April 15. Att. 18.

University of California

ENGINEERING OPPORTUNITIES IN FOREIGN COUNTRIES, by R. W. Shoemaker. C. Van Camp, student, described the work being done in the physics dept. with high velocity protons. April 12. Att. 30.

Carnegie Institute of Technology

Smoker. April 22. Att. 50.

THE WORK OF A CONTROL ENGINEER, by A. C. Dyer, Elec. Controller & Mfg. Co. Election of officers: W. Uffelman, chmn.; R. S. Fish, vice-chmn.; Wm. H. Nichols, secy.; S. J. Hyle, treas. May 4. Att. 20.

Case School of Applied Science

Election of officers: N. T. Dennis, vice-pres.; W. C. Jenner, secy.; C. L. Fantur, treas. May 4. Att. 40.

Catholic University of America

PROBLEMS CONFRONTING THE ENGINEERS OF MODERN TELEPHONE COMPANIES, by Francis Wheeler, Chesapeake & Potomac Tel. Co. April 13. Att. 40.

Clarkson College of Technology

Demonstrations and luncheon. Guests of the Science Club of St. Lawrence Univ. April 5. Att. 25.

Motion pictures. April 18. Att. 47.

Election of officers: B. Zimbee, chmn.; J. Sullivan, secy.; W. Harper, treas. April 28. Att. 27.

Clemson Agricultural College

ENGINEERING FEATURES OF THREE POWER LOCOMOTIVES, by J. L. O. Foster, student; STEAM VS. ELECTRICITY FOR DRIVING POWER STATION AUXILIARIES, by H. A. Clayton, student; THE FUTURE ENGINEER, by S. E. Lowry, student. Feb. 18. Att. 28.

STABILITY EXPERIENCES WITH CONOWINGO HYDRO PLANT, by A. E. McCall, student; TAPE ARMORED TELEPHONE TOLL CABLE, by T. M. Watson, student; A CORONA TUBE VOLTAGE REGULATOR, by H. M. Rogers, student. March 17. Att. 17.

INTERCONNECTIONS OF ELECTRIC POWER SYSTEMS, by W. W. Dickson, student; A QUIET POWER HOUSE, by F. H. Williams, student; A PORTABLE RADIO BEACON, by W. H. Gist, student. April 7. Att. 30.

University of Colorado

Election of officers: S. W. Hannah, pres.; A. H. Logan, vice-pres.; J. S. Kenyon, secy.; E. C. Sparrow, treas. April 6. Att. 20.

Prof. M. S. Coover outlined the activities at the summer convention held last June. April 20. Att. 25.

THE APPLICATION OF ELECTRICITY TO MINING ON THE WITWATERSRAND, by E. A. Faber; A STUDY OF RECTIFIER FILTER SYSTEMS USED IN COMMUNICATION SYSTEMS, by F. Wickenkamp, Univ. of Wyoming; APPLICATIONS OF NON-LINEAR CIRCUITS TO ELECTRICAL ENGINEERING PROBLEMS, by F. W. Cooper and T. M. Austin, Univ. of Colo.; MAGNETISM AND DIAMAGNETISM, by E. R. Gertner and E. Olcott, Univ. of Denver. Joint meeting with the Denver Sec., and students of Univ. of Denver, Colo. School of Mines, Colo. Agri. Col., and Univ. of Wyoming. April 29. Att. 65.

University of Denver

EXPERIENCES AS A COPPER METALLURGIST IN CHILE, by Carol Craven. Illus. April 8. Att. 28.

Annual conference on student activities of District No. 6. April 15-16.

Drexel Institute

Students attended the student Branch convention held at Haverford Col. March 14.

INSULATOR STRING POTENTIOMETERS, by A. F. Werner, student. March 16. Att. 17.

Duke University

HISTORY OF ELECTRICITY, by T. Finger, student. April 28. Att. 13.

University of Florida

PROBLEMS FACING A YOUNG ENGINEER AND THE QUALIFICATIONS HE CAN OFFER, by Mr. Garlington, Florida Pwr. Corp. April 20. Att. 55.

Election of officers: G. W. Hostettler, chmn.; J. E. Caraballo, vice-chmn.; B. A. Barnes, secy.-treas. May 2. Att. 15.

Georgia School of Technology

Inspection trip through the Southern Bell Tel. & Tel. Co. April 19. Att. 52.

Harvard University

AUDIBLE LIGHT, by J. B. Taylor, Genl. Elec. Co. April 18. Att. 350.

University of Idaho

Banquet at which Prof. R. H. Hull gave a talk on electric railways. Nov. 24, 1931. Att. 21.

Banquet and talk on electric refrigeration. Dec. 16. Att. 26.

SOME DEVELOPMENTS IN TALKING PICTURES, by K. P. Kenworthy, Univ. of Idaho; THE CALIBRATION OF A DYNATRON OSCILLATOR FROM BROADCAST HARMONICS, by Melvin Herr, Wash. State Col.; POWER SYSTEM FREQUENCY CONTROL, by Clarence Cannon, Wash. Water Pwr. Co. Joint meeting with Spokane Sec. and Wash. State Col. Branch. March 25. Att. 65.

STOCKS AND BONDS, by Dean Farmer. April 19. Att. 18.

University of Illinois

Electrical engineering show. March 31-April 1-2.

Business meeting. April 13. Att. 20.

THE MANUFACTURE OF IMPREGNATED PAPER CABLES, by R. J. Wiseman, Okonite Callender Cable Co. April 27. Att. 175.

MUSCLE SHOALS, by D. B. Allabough, student. May 3. Att. 25.

Iowa State College

THE ELECTRICAL INDUSTRY OF TODAY, by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg. Co. March 24. Att. 160.

Banquet. April 15. Att. 170.

University of Iowa

IMPROVEMENT OF THE UPPER MISSISSIPPI RIVER AND ITS RELATION TO TRANSPORTATION, by Col. G. E. Edgerton. April 13. Att. 124.

THYRATRON TUBES AND THEIR USES, by L. F. Balluff, student; ELECTROSTATIC AND MAGNETIC SYSTEMS OF UNITS, by J. E. Weyland, student. April 20. Att. 35.

Mr. Fortier, Northwestern Bell Tel. Co., gave a demonstration of the dial telephone system. April 27. Att. 44.

SYNCHRONOUS MOTORS AND THEIR ADAPTABILITY, by C. A. Bartholow, student; NEW TYPE OF HOIST AND CRANE, by L. E. Travis, student. May 4. Att. 31.

Kansas State College

THE TELEPHONE AS A BUSINESS, by Bob Gray, United Tel. Co. April 7. Att. 60.

University of Kansas

Banquet. April 8. Att. 140.

TELEVISION, by C. B. Brown, First Natl. Television, Inc. April 14. Att. 46.

CHARACTERISTICS OF TRANSFORMER OIL, by L. Sharp and J. D. Swafford, Univ. of Kansas; RUSSIA, by J. C. Bradley, Kansas State Col.; QUALITY COMPARISON BETWEEN PROBLEMS IN ENGINEERING AND PROBLEMS IN PSYCHOLOGY, by Prof. R. H. Wheeler, Univ. of Kansas; APPLICATION OF WESTON PHOTRONIC CELL TO SOUND ON FILM REPRODUCTION, by L. Farber and H. Lanning, Univ. of Kansas. Joint meeting with Kansas St. Col. Branch. May 5. Att. 100.

University of Kentucky

A BRIEF STUDY OF THE VACUUM TUBE, by W. A. Hunter, student. Feb. 10. Att. 40.

THE MERCURY ARC RECTIFIER, by Prof. E. A. Bureau. March 23. Att. 36.

Lafayette College

Prof. L. J. Conover nominated for counselor. April 29. Att. 20.

ARMATURE WINDINGS, by K. T. Sutton, student; THE HISTORY, TYPES, AND APPLICATIONS OF THE PHOTOELECTRIC CELL, by M. Ziev, student. May 5. Att. 20.

Lehigh University

MERCURY VAPOR RECTIFIERS, by G. M. Kaleda, student; DIRECT CURRENT TRANSMISSION, by Prof. S. S. Seyfert. Election of officers: B. D. Beach, pres.; C. W. Cooper, vice-pres.; Wm. D. Hickman, secy.; J. R. Fritz, treas. May 5. Att. 30.

Lewis Institute

ROMANCE OF METALS AND METAL SEPARATION, by Dr. P. B. Woodworth. May 5. Att. 185.

University of Louisville

PHASE ADVANCERS, by E. B. Wagner, student; ADVANCES IN RAILROAD ELECTRIFICATION—ESPECIALLY EUROPEAN, by Mr. Kimball, student. April 22. Att. 14.

University of Maine

ELECTRIC TRANSPORTATION, by L. Randall; CONTROL DEVICES, by R. C. Brooks; RESEARCH AND X-RAY APPARATUS, by H. Poland; RADIO, by B. Wood; LIGHTING, by E. Adams; SWITCHGEAR, by W. S. Davis; MARINE EQUIPMENT, by L. Barrett; all students. April 14. Att. 15.

Election of officers: J. P. Gonzals, chmn.; Gerald Frost, vice-chmn.; John P. Scott, secy.; F. E. Neal, treas. April 26. Att. 9.

Marquette University

Election of officers: H. A. Koepp, chmn.; C. M. Warver, secy. April 7. Att. 36.

Business meeting. April 26.

Michigan College of Mining and Technology

ELECTRO-METALLURGY, by F. Tolonen. Film—"Construction of Welded Pipe." April 8. Att. 15.

Michigan State College

Election of officers: W. C. Wright, chmn.; G. H. Kempfer, vice-chmn.; M. L. Johnson, secy. April 26. Att. 26.

University of Michigan

THE JOB AHEAD, by T. N. Lacy, Mich. Bell Tel. Co., vice-pres. A.I.E.E.; BENJAMIN FRANKLIN, by Prof. B. F. Bailey; THE WIND LINE INVESTIGATION, by Prof. W. G. Dow. Dinner. Inspection trips. Joint meeting with students of Detroit Inst. of Tech., Michigan St. Col., and Univ. of Detroit. April 28. Att. 170.

School of Engineering of Milwaukee

THE VALUE OF RESEARCH IN ENGINEERING, by H. L. Greusel, student; CATHODE RAY OSCILLOGRAPH, by L. J. Killian and E. S. Priem, students. Demonstration. April 13. Att. 84.

University of Minnesota

Discussion and motion pictures. April 5. Att. 18.

Inspection trip. April 21. Att. 95.

Missouri School of Mines and Metallurgy

Motion pictures. April 15. Att. 145.

Montana State College

ORGANIZATION AND DUTIES OF THE A.I.E.E., by Dean H. V. Carpenter, State Col. of Wash., vice-pres. A.I.E.E. Luncheon. Feb. 25. Att. 105.

NEW TYPES OF PHOTOELECTRIC CELLS, by M. T. Severud, student; COMMUNICATION WITH LIGHT, by J. O. Laird, Student; FLATHEAD POWER DEVELOPMENT AT POLSON, by E. Rothfus, student. Rudolph Stoken elected chmn. March 3. Att. 93.

FROM APPRENTICE BOY TO IMMORTAL, by J. Norlin; EFFECTS OF ULTRA-VIOLET RADIATION UPON THE EYE, by R. Wyman; THE TELEPHONE SPANS THE PACIFIC, by C. Anderson; INSULATION MATERIALS, by H. A. Beck; 1931 ACCOMPLISHMENTS IN TELEPHONE FIELD, by E. Bianchard; ELECTRICAL APPARATUS FOR TROLLEY BUSES, by D. A. Nauck; all students. April 14. Att. 82.

GUIDING PLANES BY RADIO, by V. Bauer; DISTRIBUTING PROGRAMS IN THE WALDORF-ASTORIA, by J. W. Cromer; AUTOMATIC VOLTAGE REGULATION FOR MASTER OSCILLATOR, by R. V. Dean; CABLE SERVICE UNINTERRUPTED THOUGH CHANNEL IS DREDGED, by L. Eisele; STREET LIGHTING AT INTERSECTIONS, by M. Hilden; ELECTRIC DRIVE FOR PLANT AUXILIARIES, by J. G. Lightfoot; all students. March 31. Att. 86.

OPERATING ECONOMIES OF DIESEL ELECTRIC LOCOMOTIVES, by C. L. Grebe; "DEAD SPOTS" AND HOW TO CURE THEM IN RECEIVERS, by J. D. Mathews; INTERCONNECTION OF ELECTRIC POWER SYSTEMS, by E. Rothfus; NEW PARKING DEVICE, by C. Schmitz; SOME HISTORY OF THE MODERN TELEPHONE, by R. Stokan; all students. Victor Bauer elected secy.-treas. and J. Lightfoot elected vice-chmn. April 18. Att. 87.

THE BOULDER DAM PROJECT, by L. Estey; D-C. ELECTRIC COIL TURN COUNTER, by E. Fisher; ELECTRIC HOTBEDS, by V. Hankins; THE RELIABILITY OF THE ELECTRON TUBES IN ELECTRIC SERVICE, by C. Hanson; all students. April 21. Att. 80.

SYNCHRONOUS ELECTRIC TIME SERVICE, by R. Macdonald; WHY DO POWER COMPANIES PLANT TREES? by E. Dolum; ELECTRICAL COOKING DEMONSTRATIONS, by P. B. McAdam; THE PHOTOMIC CELL, by J. Joyce; EASY TO TEST GROUND CIRCUIT, by G. Misevic; STORAGE BATTERY TRUCKS FOR SHORT HAUL TRANSPORTATION, by E. Hughes; all students. May 5. Att. 83.

University of Nebraska

Discussion and demonstrations on transients, by Prof. L. A. Bingham and Mr. Bollman. April 27. Att. 43.

Newark College of Engineering

WELDING, by S. Fishman. Election of officers: J. G. Woehling, pres.; A. E. Day, vice-pres.; L. Kufyniak, treas. April 18. Att. 25.

University of New Mexico

THE X-RAY AND ITS DEVELOPMENT, by Harold Deck, Genl. Elec. Co. May 5. Att. 25.

New York University

Election of officers: Wm. J. Sutton, chmn.; C. E. Hutchinson, secy. April 19. Att. 16.

North Carolina State College

Election of officers: L. G. Atkinson, chmn.; W. C. Cheatham, vice-chmn.; Joseph Salem, secy.-treas. April 19. Att. 31.

DIESEL ENGINE FEATURES, by Prof. W. J. Dana; RECENT ELECTRICAL INVENTIONS, by C. M. Smith, student. May 3. Att. 16.

University of North Carolina

Election of officers: F. S. Black, chmn.; G. R. Mamin, vice-chmn.; G. E. Hunter, secy.; T. C. Evans, Jr., treas. NEW CORPUSCULAR THEORY OF RADIANT ENERGY (OR LIGHT), by Dr. E. K. Plyler. May 3. Att. 60.

North Dakota State College

Election of officers: L. Schweha, chmn.; R. Netherland, vice-chmn.; Vance Schneider, secy.-treas. April 9. Att. 23.

University of North Dakota

RADIO RECEIVERS, ADVANTAGES OF THE SUPERHETERODYNE, by A. Stratmoen, student; ULTRA HIGH FREQUENCY RADIO, by R. C. Moore, student. April 13. Att. 15.

University of Notre Dame

NEW DEVELOPMENTS IN TELEPHONY, by J. A. Barkson, Amer. Tel. & Tel. Co. Joint meeting with Engrs.' Club. April 4. Att. 129.

ELECTRONS AT WORK AND AT PLAY, by Dr. Phillip Thomas, Westinghouse Elec. & Mfg. Co. April 12. Att. 550.

RADIO IN GENERAL, by P. A. Darmody, student; STANDARD DIELECTRIC TEST FOR SHEET INSULATING MATERIALS, by R. V. Bugni, student; V. E. Plante, Allis-Chalmers Mfg. Co., gave a talk on synchronous condensers and synchronous machines in general. Mr. Scanlon, student, presented the usual engineering digest. April 18. Att. 56.

Ohio Northern University

Election of officers: Donald Pees, pres.; Bernard Hauber, vice-pres.; Edgar Wagner, secy.; C. Williams, treas. April 7. Att. 26.

Ohio State University

Discussion. April 6. Att. 16.

THE ELECTRIC SHOCK, by Dr. W. B. Kouwenhoven, Johns Hopkins Univ., vice-pres. A.I.E.E. Joint meeting with Columbus Sec. April 22. Att. 36.

Ohio University

THE USE OF THE F-P54 PLIOTRON IN THE MEA-

SURFACE OF X-RAY ABSORPTION COEFFICIENTS, by J. E. Edwards, student. April 20. Att. 12.

Oklahoma A. & M. College

MANUFACTURE AND USE OF METALLIC DIAMONDS, by Guy Keiser, student; GYROSCOPIC BALANCE FOR LARGE SHIPS, by P. Bobo, student. April 11. Att. 15.

SOME ASPECTS OF LIGHTING, by T. Hutchinson, student; MERCURY ARC JET RECTIFIERS, by Lynn Cox, student. Election of officers: William Trimble, chmn.; J. R. Hollis, vice-chmn.; F. Zook, secy. April 26. Att. 20.

University of Oklahoma

Discussion. Feb. 18. Att. 20.

MAJOR DEVELOPMENTS OF RADIO, PARTICULARLY ITS APPLICATION TO AVIATION, by Prof. Farrar. March 17. Att. 17.

SHORT CUT CALCULATION ON THE PARALLEL SURFACE, by H. Moody, student. April 14. Att. 17.

Oregon State College

RECENT TRENDS IN ELECTRIC APPARATUS DEVELOPMENTS, by A. W. Copley, Westinghouse Elec. & Mfg. Co., vice-pres. A.I.E.E. HOOVER DAM, by C. F. Swigert, Pacific Bridge Co. April 11. Att. 70.

Pennsylvania State College

FUNDAMENTALS OF TELEVISION, by Prof. E. B. Stabely. Demonstrations. April 15. Att. 106.

Pratt Institute

STEP BY STEP MACHINE SWITCHING DIAL TELEPHONE EQUIPMENT, by F. J. Skerritt, student; PANEL SWITCHING FOR AUTOMATIC TELEPHONE SYSTEMS, by E. P. Zawachi, student; OPERATION OF SELECTOR SWITCH AS USED IN STEP BY STEP MACHINE SWITCHING DIAL TELEPHONE EQUIPMENT, by K. D. Porter, student; ELECTRICAL EQUIPMENT IN AN INDUSTRIAL PLANT, by A. Tiffany, student. April 14. Att. 25.

Purdue University

EFFECTS OF FREQUENCY IN COMMUNICATION, by J. L. Wayne, Indiana Bell Tel. Co. April 12. Att. 45.

IRON—NICKEL ALLOYS, by Dr. M. A. Hunter. March 15. Att. 50.

Rhode Island State College

AFTER GRADUATION, WHAT? by G. B. Nichols. April 14. Att. 52.

B. G. LAMME, by J. Costanza, student; C. P. STEINMETZ, by Wm. Daly, student. April 21. Att. 10.

Rice Institute

Discussion of plans for engineers' show. March 23. Att. 27.

Discussion. April 20. Att. 21.

Rutgers University

AN INVESTIGATION OF LEAKAGE FLUX OF TRANSFORMERS, by F. P. Fisher, student. April 12. Att. 14.

University of Santa Clara

Business meeting. March 18. Att. 39.

Inspection trip. April 7. Att. 49.

Joint meeting with San Francisco Sec., and Univ. of Calif. and Stanford Univ. Branches. (See report under "Past Section Meetings.")

Election of officers: J. Russell, chmn.; J. A. O'Neil, vice-chmn.; M. Hermes, secy.-treas. May 2. Att. 9.

University of South Carolina

Election of officers: A. R. Urquhart, chmn.; H. G. Smith, Jr., vice-chmn.; E. C. Salley, secy.-treas. March 3. Att. 34.

OIL ELECTRIC CAR IN MIXED TRAIN SERVICE, by D. J. Delk, student; LATEST MIRACLES OF THE X-RAY, by H. Howard, student; WATER FOR CHICAGO'S GROWING POPULACE, by J. J. Duffie, student. April 14. Att. 33.

RELAY CONTROL EQUIPMENT AT SALUDA DAM, by E. P. Miller, Associated Gas & Elec. Co. April 21. Att. 101.

Inspection trip to the Saluda Dam. April 28. Att. 40.

South Dakota State School of Mines

Harold Hayes, student, outlined his experiences while employed by the Northwestern Bell Tel. Co. REX TARIO, student, described the inspection trip through the Homestake Mine. April 12. Att. 22.

Harold Fry, chmn., gave a résumé of the conference on student activities of District No. 6, held in Denver. April 19. Att. 40.

University of South Dakota

Election of officers: L. Johnson, chmn.; W. Houck, vice-chmn.; N. Larson, secy.-treas. April 11. Att. 10.

University of Southern California

Discussion. April 6. Att. 18.

Beach party. April 20. Att. 84.

SOUND RECORDING PROCESS, by Mr. Cummings, United Artists Film Corp. April 27. Att. 22.

Southern Methodist University

THYRATRON TUBES, by J. V. Melton, student; DEION CIRCUIT BREAKERS, by J. W. Emery, student; RECENT DEVELOPMENTS IN RADIO TUBES, by D. Ramsey and J. N. Walker, students. Jan. 5. Att. 80.

Engineers Day. Over 2,000 visitors. March 18.

PREQUALIFICATION AND THE LOWEST RESPONSIBLE BIDDER, by J. Wallace Emery, student; PROCEDURE AND DETAILS OF TURBINE OVERHAUL, by E. W. Garrett, student. April 5. Att. 18.

Stevens Institute of Technology

YACHT DESIGN, by Warren Riker, student. April 1. Att. 30.

THE IMPORTANCE OF MATHEMATICS, by Prof. R. F. Deimel. Luncheon. April 12. Att. 35.

Smoker. WHAT AN ENGINEER SHOULD KNOW ABOUT PATENTS AND THE U. S. PATENT SYSTEM, by W. H. Taylor, Jr., Pennis, Davis, Marvin & Edwards. Films—"Conquest of the Cascades" and "The Construction of Small D-C. Motors." PHOTOELECTRIC CELLS, by Dr. Harvey C. Rentschler, Westinghouse Lamp Works. April 15. Att. 100.

Syracuse University

ELECTRICAL DISCOVERIES AND EXPERIMENTS LEADING TO THE DISCOVERY OF RADIUM, by H. E. Coswell, student; THEORY OF THE MERCURY ARC RECTIFIER, by E. Murphy, student. April 15. Att. 21.

HISTORY AND DEVELOPMENT OF ELECTRIC REFRIGERATION, by J. W. Truran, student. April 22. Att. 21.

Inspection trip to the Solvay substation. April 25. Att. 21.

THEATER LIGHTING, PRE-SET BOARDS, by T. J. Kelly, student. April 29. Att. 20.

University of Tennessee

Discussion. Jan. 14. Att. 34.

Election of officers: M. G. Toole, chmn.; L. G. Cockrill, vice-chmn.; H. H. Gnuse, Jr., secy.-treas. March 31. Att. 31.

ADVANTAGES OF THE A.I.E.E., by Prof. J. G. Tarboux, counselor. April 13. Att. 62.

Texas A. & M. College

THE DESIGN OF HIGH VOLTAGE LINES AGAINST LIGHTING SURGES, by A. O. Austin, Ohio Brass Co. Talk by Col. H. S. Crocker, pres. A.S.C.E. April 14. Att. 36.

University of Texas

DEVELOPMENT IN THE ELECTRICAL INDUSTRY IN 1931, by W. D. Clayton and H. F. Allen, both of the Genl. Elec. Co. March 23. Att. 63.

INSULATORS, by A. O. Austin, Ohio Brass Co. April 19. Att. 62.

THE DEVELOPMENT OF PUBLIC UTILITIES, by David Laves. April 28. Att. 10.

University of Utah

CUTLER DAM POWER PLANT, by S. Kettleman, Utah Pwr. & Lt. Co. Election of officers: Frank Carman, chmn.; G. E. Bossard, vice-chmn.; Simon Ramo, secy.-treas. April 27. Att. 30.

University of Vermont

THE MAGNETIC PROPERTIES OF COMPRESSED POWDERED IRON, by F. P. Kenyon, student. HYDROGENIZED IRON, by Prof. Buchanan. April 11. Att. 18.

Virginia Military Institute

THE DEVELOPMENT OF GASEOUS TUBE LIGHTING, by H. J. Geiger; THE MAGNETIC COMPASS, by J. H. Carrico; THE MOTIVE POWER FOR SUBURBAN ELECTRIC LINES, by W. C. Landis; VACUUM TUBES IN INDUSTRY, by J. T. Meek; THE IMPROVEMENTS AROUND NIAGARA FALLS, by S. J. Mergenhagen; all students. April 9. Att. 51.

WHAT BIG BUSINESS EXPECTS OF THE COLLEGE MAN, by R. C. Saunders; TELETYPE COMMUNICATION, by P. C. Wooters; PLANE DISPATCHING ON THE BIG AIRLINES, by W. W. Holt; ELECTRICITY IN ADVERTISING, by T. L. Moore; VISIT CONOWINGO, by E. R. Trapnell; all students. March 19. Att. 74.

THE ENGINEER AND HIS RESPONSIBILITY AS A CITIZEN, by L. Hilliard; TORQUE-ANGLE CHARACTERISTICS OF SYNCHRONOUS MACHINES FOLLOWING SYSTEM DISTURBANCE, by S. A. Singleton; TROUBLE SHOOTING ON A HIGHLINE, by H. A. Longino; U. S. NAVY REQUIREMENTS FOR DIESEL ENGINES, by W. M. Cummings; UNDERWORLD BROADCASTING STATIONS, by L. DeCamps; all students. May 2. Att. 43.

Virginia Polytechnic Institute

INCREASING BRUSH CAPACITY, by G. R. Elder; A STUDY OF LIGHTING ON TRANSMISSION LINES, by E. W. Whitmer; THE OPERATION OF MERCURY VAPOR TURBINES, by N. L. Gregg; THE POINT-O-LITE, by A. R. Neal; HYDROELECTRIC PLANT AT LYNCHBURG, VA., by M. L. Simpson; all students. April 21. Att. 27.

Election of officers: P. H. Cross, chmn.; N. L. Gregg, vice-chmn.; W. L. Young, secy. May 5. Att. 43.

State College of Washington

THE ELECTRIFICATION OF THE GREAT NORTHERN RAILWAY THROUGH THE CASCADE TUNNEL, by G. H. Walker, Great Northern Railway. Film—"The Conquest of the Cascades." April 15. Att. 130.

PROBLEMS ARISING WITH THE COMMERCIAL ENGINEER, by B. H. Collison, Pacific Tel. & Tel. Co. April 19. Att. 52.

University of Washington

THE POWER POSSIBILITIES OF THE COLUMBIA RIVER, by Eugene I. Pease. April 18. Att. 22.

COMMERCIAL USES OF THE VACUUM TUBE, by J. T. Copley, Genl. Elec. Co. April 20. Att. 79.

Glenn Parker, U. S. Geological Survey, spoke on water power sites and stream gaging. May 3. Att. 128.

Washington University

ELECTRONS AT WORK AND AT PLAY, by Dr. Phillips Thomas, Westinghouse Elec. & Mfg. Co. Demonstrations. May 1. Att. 250.

West Virginia University

TELEPHONE, by R. W. Blair; POWDERED FUEL AND ASH PRECIPITATION, by P. Skaff; SPRINGDALE POWER PLANT, by J. L. Simpson; WESTINGHOUSE HIGH TENSION LABORATORY, by M. L. Sprigg; PITTSBURGH EQUITABLE METER CO., by J. Kayuha; COLFAX POWER PLANT, by C. J. DeLancy; PITTSBURGH TELEPHONE EXCHANGE, by E. L. Engle; ELECTRICAL EQUIPMENT OF THE CARNEGIE STEEL CO., by A. W. Friend; PITTSBURGH EQUITABLE METER CO., by W. C. McMillion; all students. April 12. Att. 29.

WESTINGHOUSE RADIO STATION KDKA, by D. C. Kennedy; ELECTRICAL EQUIPMENT OF THE CARNEGIE STEEL CO., by H. V. Locker; ELEVATOR HOISTING EQUIPMENT AND CONTROL, by E. J. Williams; DIRECT STROKES IN TRANSMISSION LINES, by J. E. Wallace; MESTA MACHINE CO., by V. S. Monteith; WESTINGHOUSE ELEC. & MFG. CO., by P. Vannoy; HIGH TENSION TESTING LABORATORY, by L. Kirwin; SPRINGDALE POWER PLANT, by C. J. McCormick; all students. April 19. Att. 29.

University of Wyoming

LABOR, by E. K. Nelson, city engr. Joint meeting with A.S.M.E. Branch. April 12. Att. 11.

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the address as it now appears on the Institute records. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Andrese, S. C., 2224 Charnwood Ave., Los Angeles, Calif.
Archbold, Earl J., Box 2641, Birmingham, Ala.
Brentnall, E. L., W. R. Hendrey Co., Hoge Bldg., Seattle, Wash.
Bugg, Vernon, 736 Transportation Bldg., Washington, D. C.
Grable, Joseph P., Genl. Cable Corp., Ft. Wayne, Ind.
Iwe, Halfdan G., 229 Ovington Ave., Bklyn., N. Y.

Miyamoto, Tatsuo C., 1330-4th St., Sacramento, Calif.
Palit, Hari-Charan, 151 Ganesh Mohal, Benares City, India.
Rogge, C. A., Consumers Pwr. Bldg., Jackson, Mich.
Scanlon, D. L., KFPW, Ft. Smith, Ark.
Schwartz, Carl, 410 Cathedral Pkwy., N. Y. City.
Thomas, Earl Mead, Intl. Genl. Elec. Co., Schenectady, N. Y.
Titland, Trygve T., 1019 Stanton Ave., Elizabeth, N. J.
Van Ness, L. G., 2105-6 Sterick Bldg., Memphis, Tenn.
Vetri, L., Western Elec. Co., Inc., 100 Central Ave., Kearny, N. J.

Employment Notes

Of the Engineering Societies Employment Service

Positions Available

LARGE ELEC. AND MECH. MFG. CONCERN in Europe requires an executive designing engr. for their oil switch division. Fully trained E.E. of Swiss origin, thoroughly experienced in the modern design and construction of high tension overhead equipment, especially oil switches. Must have executive ability and speak German fluently. Apply by letter stating complete information as to age, education, experience, references, salary, etc. W-3754-CS.

A COMPANY MFG. a diversified line of elec. apparatus wishes to fill the position of supt. in a medium size plant in the Middle West. Applicant must be a graduate of a tech. univ., have a good personality, executive ability, and a knowledge of modern mfg. methods and equipment, supported by 10 to 20 yr. actual experience. Apply only by letter. W-3782-R-501-C.

Men Available

Agents' Representatives

MFRS'. AGT. OR SALES ENGR., sales connection desired, 42. Twelve yr. engg., 8 yr. sales experience. Tech. col. education and also war training at naval academy. Willing to go anywhere—New England States preferred. D-783.

Construction

ELEC. CONSTRUCTION ENGR., 33; 10 yr. practical experience in elec. construction work on new buildings. Familiar with all branches of electrical contracting including estimating, field engg., and purchasing. Has been in complete charge of elec. work in various large building projects in New York City. A-850.

Design and Development

E.E. GRAD., 31, single, 8 yr. experience in design of regulators and transformers. Desires position with utility or mfg. concern. Location, immaterial. Available on short notice. Excellent references. D-774.

ELEC. DESIGN ENGR., A.B., E.E., 33, married, Westinghouse elec. design school. Nine yr. responsible experience in design of d-c. motors and generators; also successful development work. Expert on commutation. Desires design work or teaching. Available on short notice. Location, immaterial. C-201.

E.E. GRAD., 28, married, 6 yr. experience in ry. signal engg., steam and elec. rys. Familiar with circuit design, estimating, installation, and maintenance of a-c. and d-c. signaling equipment. Also 1 yr. experience on steam r.r. electrification. Willing to go anywhere. C-6914.

ELEC. AND MECH. DESIGN ENGR., 41, 16 yr. experience in design and development of elec. apparatus for large quantity production; 5 yr. specializing in cost reduction design on apparatus in highly competitive field. Experience covers control apparatus, radio, refrigeration, and talking pictures. Best of references. East preferred. Available immediately. C-4977.

ELEC. DESIGNER, col. grad., 15 yr. engg. experience, comprehensive knowledge design of generating plant and substation. Expert switchboard engr., including diagrams, control, relays, etc. Desires position with utility. Available immediately. Location, immaterial. D-482.

ELEC. DESIGNER ENGR., 30, single, 10 yr. experience in design of complete elec. systems, substations, hydro-stations, industrial maintenance. Responsible, capable asst. to engr. Educated in Sweden, B.S. in E.E., American citizen, linguist. Location, immaterial. D-914.

Executives

MEMBER, 42. Extensive and diversified executive experience here and abroad. Communications engg.; utilities; corporate organization and mgmt.; personnel; sales. Contacts everywhere. Unusual and easily verified record of achievement. Qualified as a corporate secy., treas., sales engr., or as asst. to busy executive. D-730.

ELEC.-MECH. ENGR., 36, 6 years' consulting experience with large western firm, architects and engrs. Contact man. Entire charge large projects in central station and industrial field. Seven yr. design and construction large eastern utility. Registered New York. Speaks French. Will consider anything anywhere. Available May 15. D-52.

E.E., 37, married, 12 yr. experience in design of substations, elec. installation of ships, statistics, valuation, estimates. Best references from large firms in Germany and U.S. Prefer to represent American firm in Germany, Austria, or Switzerland. D-812.

E.E., grad., 42, 5 yr. supervision elec. maintenance r.r. Six yr. head elec. and mech. maintenance group of coal mines. Eight yr. assoc. editor coal mining magazine, experienced equipment photography, wide acquaintance, numerous excellent references. B-7563.

SUPT. of distribution, grad. Lowell Inst. Sch., auspices Mass. Inst. of Tech., elec., industrial mgmt. courses, 44, married. Twenty yr. elec. utility operating experience, engg., instruction, operation, maintenance of distribution, transmission lines, substations, transportation, first aid, and educational work. Has sufficient utility operating experience to qualify for position of supt. C-8411.

E.E., married, E.E., M.E. Twenty-two yr. experience, designing, construction pwr. plants, substations, transmission, distribution systems, industrial plants. Three yr. charge purchasing engineering equipment, foreign interests. Three yr. executive experience charge engg. dept. large utility syndicate. English, German, Russian, Armenian languages. Available immediately. D-84.

E.E. GRAD., Univ. of Wis., 33, single, 3 yr. Westinghouse Test, 7 yr. supervising pwr. plants, substations, transmission line construction. Four yr. engg. inspection, purchasing, expediting, traeing, res. engr., and writing specifications. Excellent reference. Can handle responsibility. Wants connection, utility, holding company, contractor, or mfr. Available immediately. Location, immaterial. B-9661.

E.E., 40. Eighteen yr. operating and engg. experience with large pwr. companies and in central holding company's engg. dept. Desires position as chief engr. small or moderate sized company or as asst. for large company. C-9291.

E.E. GRAD., 32, single, valuable experience in construction and E.E. dept. of large utility and as asst. genl. mgr. with mfr.; also selling experience. Glad to furnish references. Very willing to travel over large territory. Location, immaterial. D-745.

GRAD. ENGR., American, 27 yr. experience in design, erection, operation, and maintenance of all kinds of machy. Recently in charge of 35,000-hp. elec. installation. Expert on central station rates and contracts. Small salary acceptable in order to secure employment. C-6200.

E.E., E.E. degree. Fourteen yr. experience utilities covering valuation work, rate investigations, engg. pwr. plants, substations, transmission lines, including estimates, specifications, design. Experience covers short circuit studies, stability analysis, investigations of systems for load conditions. Desires position, holding company, operating company, or engg. firm. Available immediately. C-9870.

E.E., 40, married, 18 yr. experience utilities and industrial plants as mgr., supt., chief engr., wide experience steam, Diesel, hydro plants, manufactured gas, telephone, utility accounting. Good record, excellent references. Accept anything. Available immediately. Location, no preference. D-909-325-C-1-San Francisco.

E.E. GRAD., married, 20 yr. experience abroad and in U.S.A. estimating, designing, and inspection of elec. pwr. and light layouts, including 2 yr. charge of elec. and steam plant in iron mine, 6 yr. research and 2 yr. sales experience in lamp and metal industries. Available at once. B-9034.

EXECUTIVE. E.E., grad., married, 30 yr. experience mgr., supt., elec. engr., construction, operation, utilities. Installed steam-Diesel-hydro-electric plants. Building substations, transmission lines, distributing systems, street car network, laying underground and undersea cables. District mgr., sales representative for mfrs. of H.T. oil circuit breakers, switches, transformers. Available now. B-2388.

E.E., 30, married, 5 yr. transmission, distribution dept., utility, 2 yr. chief engr. talking moving picture company, 1½ yr. engr., wiring specifications for architects of tel. & tel. buildings. One yr. experience making Neon tubes. Designed, made apparatus for making "structural stress" and "wind pressure" test in Empire State Bldg. C-6577.

E.E., univ. grad., pwr. experience, desires position with pwr. or mfg. company. Development work preferred but not essential. B-1923.

E.E., Univ. of Ill., 12 yr. experience in design, manufacture, and sales of elec. machinery. At present chief engr. and sales mgr. Middle West

ENGINEERING SOCIETIES EMPLOYMENT SERVICE

57 Post St.
San Francisco

205 West Wacker Drive
Chicago

31 West 39th St.
New York

MAINTAINED by the national societies of civil, mining, mechanical, and electrical engineers, in cooperation with the Western Society of Engineers, Chicago, and the Engineers' Club of San Francisco. An inquiry addressed to any of the three offices will bring full information concerning the services of this bureau.

Men Available.—Brief announcements will be published without charge; repeated only upon specific request and after one month's interval. Names and records remain on file for three months; renewable upon request. Send announcements direct to Employment Service, 31 West 39th Street, New York, N. Y., to arrive not later than the fifteenth of the month.

Opportunities.—A weekly bulletin of engineering positions open is available to members of the cooperating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

Voluntary Contributions.—Members benefiting through this service are invited to assist in its furtherance by personal contributions made within 30 days after placement on the basis of 1.5 per cent of the first year's salary.

Answers to Announcements.—Address the key number indicated in each case and mail to the New York office, with an extra two-cent stamp enclosed for forwarding.

plant mfg. elec. motors. Can handle designing, sales, or plant operation. Available soon. Location, immaterial. C-7029.

Inspection

ENGR.-INSPECTOR. Past 8 yr. in charge of inspection dept. of large transformer mfr. Ten yr. design experience. E.E. deg. Desires position, preferably as head of inspection dept., but will consider other lines in which transformer experience from drafting board to operation would be of value. B-2409.

Instruction

FORMER CORNELL INSTRUCTOR IN MACHINE DESIGN for 4 yr., Allis-Chalmers designer and checker 5 yr., M.E. and E.E. deg., shop apprenticeship and miscellaneous experience. 32, single. Desires teaching or engg. opportunity. Salary open. D-122.

UNIV. GRAD., B.S. and E.E. degrees, 41. Experience Westinghouse, utilities, U. S. Government and mining companies. Six yr. asst. prof. of elec. engg. and 1 yr. acting head of elec. engg. dept., state institution. Desires position teaching elec. engg. C-5021.

E.E. GRAD., M.S. deg., 28, married. Two yr. G.E. Test and radio development lab. Three yr. as radio engr. and district service mgr. in charge of service activities in 8 states with large radio mfg. concern. One yr. teaching elec. engg. Location, U.S. Available in June. D-871.

GRAD. E.E., 27, desires position teaching mathematics, E.E. subjects, or lab. work. One yr. G.E. Test, 1 yr. design engr., 3 yr. industrial mgmt. Experienced evening school teacher. Good ability, highest references. Available June. Location, immaterial. D-920.

INSTRUCTOR, grad. E.E. with practical experience in maintenance and as sound engr. D-815.

Junior Engineers

E.E., 25, B.S. in E.E. in 1930 from mid-western school, location does not make any difference. G. E. Test experience, and about 2 yr. of wiring and repair work. Salary second to a position. D-433.

M.E.E. deg. 1930, Rensselaer Poly. Inst., single, 24, candidate for the deg. of Doctor of E.E. this June, good scholastic record. Desires connection with any utility or mfg. concern or teaching. Salary not of primary importance, available this June. Location, any part of U.S.A. or India. D-469.

GRAD. E.E., 1931, A.B., B.S., 25, single. Substation experience while student. Eight months as draftsman on wire work involving catenary design in connection with r.r. electrification. East preferred. Available immediately. D-795.

E.E., B.S. from Ohio Northern Univ., class of 1932, 23, single and excellent physical condition; willing to work hard. Have had considerable experience as salesman. Interested in any position where an engg. knowledge is required. Excellent references. Correspondence invited. Available in June 1932. Location, immaterial. D-787.

E.E., grad. 1931, Northeastern univ., cooperative plan, 22, single. Three yr. experience test and servicing elec. equipment and motors. Desires connection with construction or utility concern. Location, immaterial. Available at once. D-849.

GRAD. E.E., 27, married. Three yr. with utility on generating and substation design and layout, including switchboard and control. Two yr. industrial pwr. application. Desires position with utility co. or mfg. concern. Location, immaterial. Available one month. D-861.

GRAD. E.E., 22, Rensselaer Poly. Inst. 1930. Member Sigma Xi. Two yr. experience in plant dept. of telegraph company. Desires position with advancement in any engg. field. Salary immaterial at start. Location, North Eastern U.S. Available at once. D-785.

B.S. in E.E. Case Sch. of Applied Science 1929, 27, married; 2½ yr. with ry. signal company in construction, testing, inspection, drafting, circuit design, and creative advertising. Two yr. practical surveying. Thoroughly familiar with the principles of illumination. Available at once. Location, immaterial. D-870.

1931 GRAD. E.E., mid-western college, 24, single. Three yr. experience in genl. maintenance, construction, and motor testing. Location, immaterial. Available at once. D-572.

GRAD. B.A. (Physics), 1932, single, 22. Desires position in elec. industry. Office experience in maintaining charts and statistics. References. Location, South West preferred, but elsewhere considered. Available on short notice. D-822.

E.E. GRAD., 1930, Carnegie Inst. of Tech., 24, single. Laboratory experience while working way through school. Two yr. experience in teletypewriter and telephone communication. Permanent position desired. Available immediately. Location, immaterial. D-881.

B.S. IN E.E. 1932, Brown Univ., editorial and advertising experience. Industrial work preferred. Good mgr., applied psychologist. Thorough understanding of d-c. and a-c. machinery, transmission lines, auxiliary apparatus, testing, and applications. General knowledge includes economics, hydraulics structures, etc. Cultured, industrious, and clever. D-742.

POSITION DESIRED by young engr., 26, col. grad. Has had two yr. G.E. Test and 3 yr. in d-c. dept. of G.E. Company on design and cost estimating of synchronous converters. D-882.

E.E., grad., 1931, 25, single, cooperative college. Twelve months' experience as asst. in production lab. of battery mfg. concern. Six months' experience as a general draftsman. Speaking and reading knowledge of German. Desires position with a future. Location and salary secondary. Available immediately. D-534.

GRAD. E.E., 1931, U. of M., single, 22. Seven months' student sales engr. Wagner E. Test. Nine months' experience elec. maintenance and construction industries equipment, Ford Motor Co., six months' salesman. Desires position elec. motor industry or utility with opportunity for advancement. Location, Michigan and adjacent states preferred. Available immediately. D-719.

1931 GRAD., 28, single, 8 yr. machine shop. Wishes any kind of work or study and research to obtain master's degree. Location and salary not material. Available at once. D-916.

E.E., 28, single. Experience in general engg. and research lab. of the E. Also 1 yr. of G.E. Test. Desires position with a laboratory, utility, or mfg. concern. Available July 1. Location in the East. D-915.

GRAD. E.E., Columbia Univ. 6 yr. course, 1932; single, 24. Desires work with utility, r.r., mfg. concern, or construction corporation. Would like to teach E.E. subjects. Location and salary immaterial. D-893.

E.E. GRAD., 1932, 24, single. B.S. in E.E. from well-known engg. school. Good scholastic record. Four yr. mfg. experience includes timekeeping, cost work, maintenance, and assembly. Desires position with opportunity for advancement with utility, engg., or mfg. firm. Location preferred, Ohio-Pa. vicinity, but will consider others. D-908.

1931 GRAD., E.E., B.S., leading western univ., 27, single. Telephone work, machine shop apprenticeship, draftsman, and machine designer. Familiar with vacuum tubes, good mathematician. Excellent scholastic record. English, German, Swedish, Finnish, and Spanish languages. Desires position with industrial firm. Location, immaterial, U.S. or abroad. Available on short notice. D-923.

1931 GRAD. in E.E., B.S. from Clemson Agri. Col., 25, single. Desires work with utility, mfg. concern, or construction corporation. Available immediately. Location, immaterial. D-400.

STUDENT, 25, single, B.E.E. '32, Univ. of Detroit, 8 yr. radio-telephone experience, 1½ yr. of which with police dept., the rest broadcasting. Would like position with large station or chain, if possible. Location, immaterial. Holds 2nd class commercial operator's license. D-926.

Maintenance and Operation

E.E. GRAD., 1927, married. Eight yr. steam plant operation and maintenance, and factory maintenance. Now unemployed. Location preferred, Middle West or Western. C-8822.

M.E., E.E., AND C.E., graduated Italy, 30, single. Executive experience. Desires position anywhere with utility or contractor. Three yr. varied civil engg., 2 yr. in pwr. production in steam and hydroelectric plants. Skilled in any layout, topographic, and maintenance work. D-422.

ELEC. RY. ENGR., 36, grad. E.E. Extensive experience in all phases of elec. and street ry. work including plants, substations, transmission, trolley and telephone lines, elec. locos., interurban and city cars, also lighting of steam trains, etc. Record of rapid advancement. Good organizer. Speaks Spanish. C-9557.

Research

PHYSICIST, 33, married, grad. and post-grad. work at Harvard. Eleven yr. experience in development laboratories, mostly with vacuum tubes and Neon lamps. Good knowledge of high frequency currents and theoretical mechanics. B-8390.

Sales

SALES MGR.-ENGR., 35, experienced capable sales contact man, desires connection as representative or mfrs. agt. with high grade company mfg. line of high or low voltage equipment for utilities or industrial plants. B-4067.

SALES ENGR., E.E. grad., 30, married, 5½ yr. experience in utility work involving pwr. station operation and maintenance; pwr. station and substation design. Teaching experience. Fourteen months' application sales engg. experience with control mfg. concern. Desires position as salesman or application engineer. Available immediately. D-713.

MFRS. AGT. OR SALES ENGR., British engr. (American papers) mech., elec., 36, single. Thorough knowledge of several British Colonies and Spain. Six years industrial sales engr., specializing industrial heat, large western utility, desires connection American firm contemplating plant or sales office within British Empire, South America. Fluent Spanish, French. Available immediately. D-806.

E.E. GRAD., 30, family, 2½ yr. telephone engr., 2 yr. sales mgr. for automotive jobbing house, 2 yr. field engr. for elec. light company, with a total of 2½ yr. drafting on tool and machine design. Desires work of any kind or type paying living wages. Location, immaterial. C-951.

ELEC.-MECH. ENGR., 39, married. G.E. student course. Eighteen yr. experience sequence motor control systems, industrial engg., sales, patents, investigations and reports, machinery development. Prefers connection as industrial consultant or as sales engr. C-9552.

Testing

GRAD. E.E., 29, single, B.S., Union College, 1929. One yr. with Underwriters' Lab., 2 yr. Otis Elevator Co., development and test dept. Familiar with all types of elevator and escalator equipment. Desires position designing and testing of industrial control equipment. Available at once. Location immaterial, preferably the South. D-559.

Membership

Recommended for Transfer

The board of examiners, at its meetings on the dates given recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the acting national secretary of the Institute.

To Grade of Fellow (May 18, 1932)

Christie, Clarence V., prof. of elec. engg. and head of dept., McGill Univ., Montreal, Can.
Lovell, Wm. V. (retired), Stanford, Florida
Rees, John B., equip. and bldg. engr., Am. Tel. & Tel. Co., New York

To Grade of Member (April 13, 1932)

Anderson, Albert S., central station dept., Genl. Elec. Co., Denver, Colo.
Anderson, Henry C., asst. engr., N. Y. & Q. Elec. Lt. & Pwr. Co., Flushing, N. Y.
Blume, Norman H., wire chief, Wisconsin Tel. Co., Madison.
Buchanan, Wm. B., testing engr., Hydroelectric Pwr. Comm. of Ont., Toronto.
Crowdes, George J., asst. elec. engr., Simplex Wire & Cable Co., Cambridge, Mass.
Grauten, S. H., acting development engr., Pub. Serv. Co. of No. Ill., Chicago.
Hayden, C. B., service engr., Pub. Serv. Comm. of Wis., Madison.
Houghton, M. G., supervisor of elec. engg., Detroit Inst. of Tech., Detroit, Mich.
Hull, R. M., division distribution engr., Pa. Pwr. & Lt. Co., Allentown.
Marconi, C. G., elec. engr., Elec. Bond & Share Co., New York.
Perreten, Arnold E., asst. elec. distribution planning engr., Pub. Serv. Co. of Colo., Denver.
Peterson, T. F., consulting cable engr., Am. Steel & Wire Co., Worcester, Mass.

Ready, Lester S., consulting engr., San Francisco, Calif.
Sealey, Wm. C., elec. engr., Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Skooglund, Carl M., pwr. station design engr., West Penn Pwr. Co., Pittsburgh, Pa.
Spaulding, G. W., asst. to genl. supt., Pa. Water & Pwr. Co., Baltimore, Md.
Steinberg, Max J., elec. field engr., Brooklyn (N. Y.) Edison Co.
Stevens, Earl E., elec. testing engr., Commonwealth Edison Co., Chicago, Ill.
Weidlein, Wm. D., engr., Black & Veatch, Kansas City, Mo.
Wendell, R. B., design engr., Pub. Serv. Co. of No. Ill., Chicago.

To Grade of Member (May 18, 1932)

Bostwick, Wm. E., inspector, Pa. R.R. Co., Altoona, Pa.
Burlingham, Kenneth R., chief electrician, Milwaukee County Institutions, Wauwatosa, Wis.
Cockburn, John M., telephone systems engg. dept., Northern Elec. Co., Montreal, Can.
Damania, Sorab B., engr.-in-charge, Ambernath Elec. Supply Serv., Ambernath, G.I.P. Ry., India
Ege, Wm. W., dist. mgr., Copperweld Steel Co., Chicago, Ill.
Ekeroth, Walter M., asst. engr., Brooklyn (N. Y.) Edison Co.
Langwig, Frank I., asst. engr., N. Y. Telephone Co., Albany
Lewis, Ephraim H., genl. mgr., Union Elec. Lt. & Pwr. Co., and St. Louis County Gas Co., Webster Groves, Mo.
Lightband, Denis A., designing elec. engr., Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.
Tang, Kwan Yau, prof. of elec. engg., Ohio State Univ., Columbus, Ohio
Travers, Fred H., engr., Genl. Elec. Co., Bridgeport, Conn.

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Unless otherwise indicated, the applicant has applied for admission as an Associate. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the acting national secretary before June 30, 1932.

Brainerd, J. G., Univ. of Pa., Phila.
Briggs, A. S., Jr., Phila. Elec. Co., Phila., Pa.
Campbell, F. W. (Member), Westinghouse Elec. & Mfg. Co., Cleveland, Ohio
Carlson, E. J., Univ. of Calif., Berkeley
Casavant, F. C., Syracuse (N. Y.) Lt. Co., Inc.
Coffinberry, C. M., Elec. Engg. Sales Co., Los Angeles, Calif.
Crump, L. L. (Member), James R. Kearney Corp., St. Louis, Mo.
Davidson, L. A., Okla. Gas & Elec. Co., Oklahoma City
Deming, A. F., Natl. Advisory Committee for Aeronautics, Langley Field, Va.
Harrison, E. T. C., Southwestern Bell Tel. Co., Oklahoma City, Okla.
Held, C. A. (Member), Monks & Johnson, Boston, Mass.
Henshaw, W. J., Vancouver Pwr. Co., Lake Buntzen, B. C.
Hoover, H. C., Wagner Electrical Corp., Washington, D. C.
Johnston, A. B., Southwestern Bell Tel. Co., Oklahoma City, Okla.
La Chapelle, H. C., Am. Tel. & Tel. Co., Denver, Colo.
Luckenback, C. E., York Ice Machinery Corp., York, Pa.
Mahaney, D. J., Southwestern Bell Tel. Co., Oklahoma City, Okla.
McCluskey, F. J., James R. Kearney Corp., St. Louis, Mo.
McLean, C. H., British Columbia Telephone Co., Vancouver, B. C., Can.
Parkhurst, E. T., 79 Walnut St., Somerville, Mass.
Pedersen, A. H., Automatic Temperature Control Co., Germantown, Phila., Pa.
Pendleton, V. A., Oklahoma Gas & Elec. Co., Oklahoma City
Powers, C. F., New England Pwr. Engg. & Serv. Corp., Boston, Mass.
Reese, L., Pacific Gas & Elec. Co., San Francisco, Calif.
Risen, H. J., Okla. Gas & Elec. Co., Oklahoma City
Schroeppel, H. C., Memphis Pwr. & Lt. Co., Tenn.
Todd, J. M. (Fellow), 818 Maritime Bldg., New Orleans, La.
Vance, R. L., Bell Telephone Labs., N. Y. City
Wall, W. W., Natomas Co., Natoma, Calif.
Woll, L. B., 741 Fairmount Place, N. Y. City
30 Domestic

Foreign

Headland, H., Public Wks. Dept., Waitaki Hydro, South Island, N. Z.
Hickey, M. G., Hackbridge Elec. Construction Co., Hersham, Walton-on-Thames, Surrey, England
Sawhney, B., Associated Electrical Industries, Lahore, India
3 Foreign

Engineering Literature

New Books in the Societies Library

Among the new books received at the Engineering Societies Library, New York, during April are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no reponsibility for statements made in the following outlines, information for which is taken from the preface or text of the book in question.

S.A.E. HANDBOOK. Complete supplement to 1931 edition. N. Y., Society of Automotive Engrs., 1932. 125 p., illus., 7x4 in., paper, $1.00 to non-members; $.50 to members.—Instead of issuing a revised edition of the handbook, the Society has published this complete supplement. Containing all new and revised standards and recommended practises adopted since the last book appeared, with a list of canceled specifications, thus bringing the work entirely up to date.

SCHWEIZERISCHE ENERGIEWIRTSCHAFT. By M. L. Keller. Aarau (Switzerland), Verlag H. R. Sauerländer & Co., 1931. 112 p., 9x6 in., cloth, 4 Swiss Frs.—A discussion of electric power development in Switzerland, its defects, and ways to better conditions. Treated from economic and political points of view. Establishment of a special government institution is advocated, patterned on the Swiss National Bank, to which the control of power developments and electricity supplies will be delegated.

SYMPOSIUM ON EFFECT OF TEMPERATURE ON THE PROPERTIES OF METALS. Am. Soc. of Mech. Engrs., N. Y., and Am. Soc. for Test. Mtls., Phila., 1932. 829 p., illus., 9x6 in., cloth, $6.00 to non-members; $5.00 to members.—Papers (27) presented at a joint meeting of the A.S.M.E. and the A.S.T.M. in Chicago, 1931; discuss various problems related to engineering trends and requirements per metals at high and low temperatures, and the properties of metals for use at these temperatures. The book ably summarizes our present knowledge of the subject and brings up to date the records of a similar meeting in 1924. A bibliography is included.

TALKING PICTURES. By B. Brown. N. Y. & Lond., Isaac Pitman & Sons, 1931. 305 p., illus., 9x6 in., cloth, $3.00.—Origin, how it works, and the practical details of the apparatus and its operation for the modern talking picture as set forth in an interesting way in this book. Successful explanation of matters in a way easily to be understood without technical training, and in presenting a comprehensive view of the industry within a moderate compass.

THE TAYLOR SERIES, an introduction to the theory of functions of a complex variable. By P. Dienes. Oxford, Eng., Clarendon Press (gift of Oxford University Press, N. Y.), 1931. 552 p., 9x6 in., cloth, 30s.—This scholarly introduction to the theory of functions of a complex variable adopts the way of approach by the methods of Cauchy and Weierstrass. The first seven chapters give the elements of the usual Cauchy-Weierstrass theory. The remaining seven chapters discuss and coordinate further developments of the theory by Picard, Hadamard, Mittag-Leffler, Borel, and others. There is a good bibliography.

WORKING FOR THE SOVIETS, an American Engineer in Russia. By W. A. Rukeyser. N. Y., Covici, Friede, 1932. 286 p., illus., 8x6 in., cloth, $3.00.—A first-hand description of industrial conditions by an American mining engineer. The author's work for the Soviet government took him to the asbestos mines of western Siberia with no companions except Russians. He had unusual opportunities to know them and to learn what they thought and how they lived. He gives an interesting account of his experiences.

ADVANCING SCIENCE. By O. Lodge. N. Y., Harcourt, Brace & Co., 1932. 191 p., 8x5 in., cloth, $2.00.—This volume sketches the work of the British Association for the Advancement of Science between 1870, when Sir Oliver Lodge became a member, and 1900. A regular attendant at its annual meetings, he has vivid recollection of the great men of that period and of the outstanding events and papers of each meeting. These he describes in an interesting manner. The discovery of the electron and the beginnings of the study of ether waves are discussed.

AMERICAN ELECTRICIANS' HANDBOOK. By T. Croft. 3d ed., N. Y. & Lond., McGraw-Hill Book Co., 1932. 1051 p., 7x4 in., leath., $4.00.—This popular handbook gives the facts about apparatus, materials, installation, and operation needed by wiremen, contractors, linemen, plant superintendents, and construction engineers in their daily work. Theory is reduced to a minimum, but sufficient is given to explain the reasons for the methods recommended. The edition has been revised to conform with current practise and the latest code requirements.

BEHEMOTH, the Story of Power. By E. Hodgins and F. A. Magoun. Garden City, N. Y., Doubleday, Doran & Co., 1932. 354 p., illus., 9x6 in., cloth, $3.50.—A narrative history of power, built about personalities which have contributed to the evolution of motive machinery, and intended for the reader without technical training. The development of the steam and internal-combustion engines, of the dynamo and hydraulic turbine, is presented in broad outline from the earliest times to the present, in an unusually readable, entertaining way.

EINFÜHRUNG IN DER EBENE GETRIEBELEHRE. By T. Pöschl. Berlin, J. Springer, 1932. 127 p., 9x6 in., paper, 9.75 rm.—An elementary textbook, designed for home study and for students in engineering colleges. Graphic methods are used and a knowledge of vectorial analysis is required. The course is planned with close attention to practical needs.

HOCHFREQUENZTECHNIK IN DER LUFTFAHRT. By H. Fassbender. Berlin, J. Springer, 1932. 577 p., illus., 10x6 in., cloth, 68 rm.—Prepared for the German Aircraft Research Institute by a number of specialists, this book is intended to present a comprehensive account of the present state of radio communication with aircraft. The theoretical principles and methods of measurement first are considered; then the problems of direction finding. The apparatus used in the different flying countries is described, after which a section is devoted to radio service for flyers. Theoretical and practical aspects of the subject are discussed at some length, and bibliographies are scattered through.

ELEMENTS OF HUMAN ENGINEERING. By C. R. Gow, ed. by F. A. Magoun. N. Y., Macmillan Co., 1932. 169 p., 8x5 in., cloth, $1.60.—The second of a series of books by the professor of humanics at the Massachusetts Institute of Technology. From his broad practical experience, Professor Gow gives sensible advice to the young engineer who is beginning his career upon the cultivation of correct personal relations with superiors and subordinates and similar topics that greatly affect his success in life but are not covered in his course of study.

NACHTRAG III ZUM WERKSTOFFHANDBUCH NICHTEISENMETALLE. Berlin, Beuth-Verlag, 1932. 14 p., illus., 8x6 in., paper, 3.50 rm.—Third supplement to the Handbook of Non-Ferrous Metals. Contains new information upon torsion testing, corrosion testing, electric melting furnaces, metal coatings, and the working of pure aluminum. The material is in loose-leaf form for insertion in the handbook.

Engineering Societies Library

29 West 39th Street, New York, N. Y.

MAINTAINED as a public reference library of engineering and the allied sciences, this library is a cooperative activity of the national societies of civil, electrical, mechanical, and mining engineers.

Resources of the library are available also to those unable to visit it in person. Lists of references, copies or translation of articles, and similar assistance may be obtained upon written application, subject only to charges sufficient to cover the cost of the work required.

A collection of modern technical books is available to any member residing in North America at a rental rate of five cents per day per volume, plus transportation charges.

Many other services are obtainable and an inquiry to the director of the library will bring information concerning them.

Annual Technical Committee Reports to the Board of Directors

In accordance with Section 82 of the A.I.E.E. By-Laws, the Technical Committees of the Institute have prepared the following reports for presentation at the Summer Convention.

To accomplish a timely circulation of these committee reports throughout the membership of the Institute, ELECTRICAL ENGINEERING presents on the following 27 pages a preprint of a portion of a future issue of the quarterly TRANSACTIONS.

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Research

ANNUAL REPORT OF THE COMMITTEE ON RESEARCH*

DURING the year 1931 the Committee on Research has encouraged the presentation of research papers and has reviewed many for sessions on research before the A.I.E.E. On account of the broad field which must be covered by this committee it has been impracticable to organize subcommittees under any specific classification. The burden of reviewing papers has fallen to practically all members and excellent cooperation has been obtained by correspondence and without committee meetings.

The following topics are worthy of mention to show the progress that has been made during the year. The subjects reported have all been suggested by committee members.

PHYSICS

Dr. R. J. Van de Graaf of Princeton University and Massachusetts Institute of Technology has developed static machines of a very simple construction using endless silk belts with which he has generated as high as 1,500 kv. This work is being extended to much higher voltages.

Dr. F. Lange and A. Brasch of the University of Berlin have built a simple X-ray tube consisting of alternate rings of paper, rubber, and aluminum which they hope to operate with voltages up to 2,500 kv.

A number of developments have taken place during the year in connection with X-ray tubes and auxiliaries. Some of these are described in the January issue of the *General Electric Review*. The application of X-rays commercially has been extended during the year to the sterilization of food and food products.

Experiments have recently been made in this country on a sodium vapor lamp, originally developed in Germany. This lamp has been made possible by a new kind of glass which is not blackened by the sodium vapor. This lamp is said to be several times as efficient as the ordinary mercury or gas filled lamp.

In ferro-magnetic materials changes in magnetization do not occur instantaneously throughout the mass of the material, but start locally and are propagated with finite velocity. This was demonstrated on a large scale by K. F. Sixtus and L. Tonks and the velocity of propagation was measured in nickel-iron wires under tension. (*Physical Review*, 37, 1930, p. 1958, April 1931.)

From the Westinghouse Laboratories a new magnetic phenomenon has been reported by F. Bitter, which consists in the discovery of magnetic inhomogeneities of a definite and regular pattern in the individual crystals of ferro-magnetic materials. These are of quite a different nature, depending on the type of material. No satisfactory explanation has yet been obtained for this phenomenon.

Members of the staff of the Alabama Polytechnic Institute have announced the discovery of the last missing element No. 85.

From theoretical considerations, it was believed that atoms of hydrogen might exist which are twice as heavy as the ordinary atoms. These have now been discovered experimentally by H. C. Urey and G. M. Murphy of Columbia University and F. G. Brickweede of the Bureau of Standards.

Walter Bathe is reported by A. H. Compton to have produced gamma rays by bombarding beryllium metal with alpha rays. His experiments indicate a possible synthesis in which a heavier element, carbon, is formed and if proved correct it may greatly affect all ideas of how the solar system and our earth originated. (*Sc. News Letter*, p. 223, Nov. 21, 1931.)

Vacuum tubes are continually extending the ranges of possible electrical measurements and thereby opening new fields of physical research. L. A. DuBridge (*Physical Review*, 37, page 392, 1931) reports measurements of small currents of the order of 10^{-18} amperes which corresponds to six electrons per second.

Fowler (*Physical Review*, Vol. 38, page 45, 1931) has made important theoretical investigations of the photoelectric threshold values of clean metals at various temperatures.

Newton Harvey (*Jl. of General Physiology*, Vol. 15, p. 147) has demonstrated that living cells are disintegrated by ultra-sonic waves in less than $^1/_{1000}$ of a second.

R. W. G. Wyckoff (*Radiology*, Vol. 17, p. 1171, 1931) has obtained important data on the destruction of micro-organisms by X-rays and cathode rays in continuation of his previous work in this field.

Boer and Teves (*Zeitsch f. Phys.*, Vol. 73, page 192, 1931) have obtained further important results in connection with their investigation of the photoelectric properties of caesium oxide films in conjunction with halide salt layers.

Bergmann (*Zeitsch. f. Phys.*, April 1, 1931) has described an important photoelectric cell involving essentially the photoelectric properties of iron selenide.

DIELECTRICS

The Committee on Electrical Insulation of the Division of Engineering and Industrial Research of the National Research Council reports very substantial progress in the study of dielectrics and dielectric phenomena. Its report, which summarizes a considerable number of recently presented papers, should be consulted by those interested in this subject. The following items, some of which were reported by the National Research Council, are of par-

* COMMITTEE ON RESEARCH:

L. W. Chubb, Chairman,
H. D. Arnold, W. P. Dobson, H. H. Race,
Edward Bennett, F. M. Farmer, C. W. Rice,
W. G. Cady, V. Karapetoff, D. W. Roper,
E. H. Colpitts, A. E. Kennelly, T. Spooner,
E. C. Crittenden, J. K. McNeely, J. B. Whitehead,
W. F. Davidson, F. W. Peek, Jr., R. J. Wiseman.

ticular interest. Some of these results have been presented in the form of papers before the Institute.

A further reference which may be consulted with profit to those interested is monograph No. 5 of the American Chemical Society, by Professor C. P. Smythe of Princeton University, giving an extensive summary of the results of the work in determining molecular structure.

The following four A.I.E.E. papers from The Johns Hopkins University on this subject by Dr. Whitehead and his associates are particularly valuable, namely, on the *Conductivity of Insulating Oils*, *The Fundamental Properties of Impregnated Paper*, *Residual Air and Moisture in Impregnated Paper*, and *The Predetermination of the A-C. Characteristics of Dielectrics*. Other valuable A.I.E.E. papers on dielectrics are *Insulation Variability*, by M. C. Holmes; *On the Theory of Thermal Breakdown of Solid Dielectrics* by P. H. Moon, and another in the same field by Kenney, Luery, and Moriarty.

In one of the above mentioned papers by Whitehead and Banos there is announced a most remarkable agreement between loss, power factor, and capacity values at 60 cycles for solid and liquid dielectrics as determined experimentally and as calculated from the d-c. characteristics as obtained by the oscillograph.

By very careful distillation and purification as reported by L. A. Welo it has been possible to produce insulating oils having conductivities of 10^{-18} to 10^{-19} ohms.

The Bell Telephone Laboratories have reported very interesting results on ordinary insulation in which they point out that it is the metallic salt content of considerable solubility in water which controls the insulation or conductivity characteristics of such materials. Washing with water improves the insulation properties decidedly and improvement can be obtained by replacing the soluble salts with more insoluble salts by chemical reaction.

Work continues in an increased amount on the subject of polar molecules in dielectrics. This subject, originally considered of no practical value, is now being studied for viscous liquids and even solids, with very important results. Development of polar molecules in insulating oils gives a measure of deterioration. The work of W. N. Stoops points out the very definite correlation and the fact that the measure of the polar characteristics under accelerated test may furnish a measure of the useful life of an oil.

Dielectric losses in highly refined insulating oils at commercial frequencies and operating temperatures have been shown to result from conduction, but at high frequencies and low temperatures the major loss may be accounted for by the orientation of polar molecules. (H. H. Race, *Physical Review*, 37, p. 430–436, Feb. 1931.)

At Johns Hopkins University and the Bell Telephone Laboratories further studies on abietic acid and rosin have been made as to the part played by dipoles in the s.i.c. and loss characteristics of material over ranges of temperature and frequency. This type of work, directed toward an understanding of the mechanism of the dielectric in detail, is most important. It is interesting to note that both sets of data can be explained by the generalized theories of Schweidler and Wagner, which consider the dielectric mass as a whole, or by the dipole theory of Debye, which considers the microscopic structure, namely, the individual atoms, molecules, or ions as dipoles.

Studies of cable oil and cable conditions at a number of laboratories were reported last year, particularly on the effect of ion bombardment on oils. The necessity for a completely filled, solid, compact cable to prevent internal ionization is further shown. For example, it has been shown by the Detroit Edison Company that the power factor of an oil is directly correlated with the amount of hydrogen freed by ion bombardment. In the studies of the fundamental properties of paper, oil, and impregnated paper at Johns Hopkins University, it was found that with high grade oil the larger portion of the dielectric loss was attributable to the paper. Further, it has been shown by the Commonwealth Edison Company that tackiness of adhesion of the compound is correlated with long life of cables.

J. A. Scott of the General Electric Company has shown that oil pressures of several atmospheres applied to impregnated paper insulated cable give a decided increase in the life of the cable as measured by an endurance test.

The increased use of the oil filled type of cable and the growing use of oil for filling joints in ordinary impregnated paper insulated cable have greatly increased the importance of the integrity of the lead sheath. Several research projects dealing with lead are in progress. Work at the University of Illinois has shown that the creep of lead and several common lead alloys occurs at stresses below 200 lb. per square inch; that is, at stresses which may occur in cable sheaths during normal operation.

Researches on transmission cables show a tendency to depend on accelerated aging tests as a measure of the life quality. Both utilities and cable manufacturers are conducting researches on long lengths of impregnated paper-insulated cable to duplicate in a short time what takes place over a period of years in service. The present indications are that, by subjecting the cable to about 2.5 times normal voltage, and at the same time superposing loading cycles resulting in a maximum temperature somewhat above the limiting temperature for the cable, and by making measurements of power factor and ionization factor at suitable intervals throughout a test continuing a week or two, it is possible to predict the effect of many years of normal service on the stability of insulation.

Considerable interest is taking place as to the influence of pressure on a cable and its relationship to the migration of the oil in the cable as it goes through its temperature cycle.

The Detroit Edison Research Department reports that chemical reactions of organic compounds in electrical discharges are being studied as a part of a program of investigation of the deterioration of oil-impregnated paper insulation of high-tension cables. The results of an experimental survey covering 57

different hydrocarbons has been published (*Jour. Phys. Chem.*, 35, 3649 (1931)).

In the field of insulation, J. B. Whitehead summarizes the accomplishments for the year as follows:

This research has been characterized by a definite extension of our knowledge of the behavior of insulating liquids and its causes. This is a result largely of the development of amplifier and oscillograph methods for measuring short-time behavior of liquids when used for the impregnation of paper with the result that a much closer insight is now possible as to the origin of the properties of high-voltage impregnated paper insulation. A continuation of the accelerated life studies on laboratory samples of impregnated paper is clearing up the uncertainties heretofore existing as to the relative importance of residual air and moisture in impregnated paper. In connection with these researches, an important method of analysis of the results of a-c. measurements has been developed and its limitations explored.

Circuit Interruption

Vacuum relays developed in Germany have been introduced into this country which make use of the flexibility of glass to transmit sufficient motion to operate contacts. This is possible because of the very small contact separation necessary in a vacuum.

Slepian and Strom in an Institute paper (Electrical Engineering, Dec. 1931) have given a valuable analysis of the factors which govern arc extinction in low-voltage network cables. It is shown that the gas blast, as the result of the action of the arc on cable insulating materials, is largely responsible for the clearing of faults. Data are given on the extinguishing characteristics of various types of chemical compounds.

By intensive research, the possibilities of boric acid in connection with circuit interrupting devices have been developed to a point where commercial applications are in sight. The production of water vapor from the boric acid by the action of the arc causes a powerful deionizing action. The water vapor may be condensed, thus making possible a very efficient enclosed fuse for high interrupting capacities.

Miscellaneous

H. B. Dwight has given a very useful analysis of the proximity effects in cable sheaths (A.I.E.E. Transactions for September). This is supplementary to the formulas published by him some years ago in the *Electric Journal*.

In the same issue of the Transactions there is a group of papers on the measurement and analysis of noise in electrical machinery which, in some aspects represents contribution of new knowledge as the direct result of careful research. The science of acoustics is becoming an important phase of electrical engineering. Since the world has become noise conscious the elimination of unnecessary noises will be only a matter of time. Some of the new portable noise analyzers which have been placed on the market this last year make the measurement of the magnitude and the analysis of noises much easier.

By studies at the Westinghouse Laboratories, of car and train models in wind tunnels, fundamental data have been obtained on the advantages of streamlining. These results will be of great value in reducing power and making possible high-speed land transportation.

R. M. Baker has discovered that the presence of small quantities of mercury vapor in a non-oxidizing atmosphere very greatly reduces the contact resistance for certain types of brushes and slip rings. This may be of some commercial value, especially where it is wished to use very high current densities. (*Elec. Journal*, February 1932).

The development of the helical groove on slip rings and commutators by G. M. Little promises to be of considerable value in connection with the problem of current collection and commutation. Field tests have shown decided improvements in brush wear, sparking and distribution of current between parallel brushes (Electrical Engineering, June 1931, p. 427).

Researches on the conditions desirable for the greatest human comfort, namely, the effect of humidity, wall temperature, air flow, and ionic condition of the air, etc., have been very active during the past year. Also the usefulness of reversed refrigeration for the heating of houses and buildings is being tried out commercially in several installations. Air conditioning is apparently to become soon a very considerable industry of great importance to the electrical interests.

Very sensitive research measurements have shown that all metals flow to some extent at high temperatures and that this flow can be reduced by using proper heat treatment of certain alloys. Such studies are used as a basis for new mechanical design of high temperature steam and electrical turbines so that proper clearance will be maintained throughout long life. (Paper presented by F. P. Coffin and T. H. Swisher at the National Applied Mechanics Meeting of the American Society of Mechanical Engineers, June 15, 1931.)

In the field of radio, Bruce's work on directive short wave antennas is of importance.

There are two recent developments in piezo-electricity worthy of note. Thin plates of tourmalin have, within recent months, shown themselves to be excellent piezo-oscillators, particularly for very short waves down to about two meters wavelength. An interesting circumstance in this connection is that, although tourmalin was one of the very first piezo-electric crystals to be studied, nevertheless the practical applications are of very recent date. Another recent application of piezo-electric crystals is their use in filter circuits of very high selectivity.

The researches on the fundamental electrical units which have been under way at the Bureau of Standards for several years have reached a stage such that preliminary values can be given, subject to some minor corrections. The results confirm earlier determinations in showing that the international ohm is 5 parts in 10,000 larger than it should be, while the

ampere has very nearly the correct value as determined by measurement of mechanical forces between coils. Comparisons of fundamental standards in recent years have shown differences between the standards of different countries large enough to be troublesome in precise scientific work. Direct comparisons between silver voltameters of the Bureau of Standards, the British National Physical Laboratory and the German Physikalisch-Technische Reichsanstalt were made during the year at Berlin; these proved that existing discrepancies arose in large part from changes in the German standard cells. Several years ago the International Committee on Weights and Measures decided that eventually the electrical units should be based upon absolute (mechanical) measurements rather than upon standards arbitrarily defined. The International Committee meets in 1933, and it is hoped that definite plans can then be approved for introducing electrical units on the new basis, assuring international uniformity of values, and removing the discrepancy between electrical and mechanical units.

Electrical Machinery

ANNUAL REPORT OF THE COMMITTEE ON ELECTRICAL MACHINERY*

Activities of the Committee

THE committee during the year has reviewed approximately 50 papers, of which 24 have actually been accepted and published. Work on the preparation of test codes has been carried on during the year, and the Transformer Test Code was published in preliminary form in October. Favorable comments have been received on this, and work on the test codes for induction machines, synchronous machines, and d-c. machines is now approaching completion.

While direct responsibility of the machinery committee for standards, except for transformers, has now been transferred to the Sectional Committee of the A.S.A., the machinery committee has participated indirectly in the revision of the rotating machinery standards, and in particular has sponsored proposals to determine accurate efficiencies of induction and direct-current motors. Mr. C. J. Koch's paper on *Measurement of Stray Load Loss in Polyphase Induction Motors*, presented at the Providence Meeting of the Institute in May 1932, is an important contribution in this field.

The transformer subcommittee has been very active in revising the Transformer Standards No. 13, and it is now undertaking the very important task of standardizing impulse voltage tests.

Revisions in the standards for constant-current transformers and in the Standards Report on Capacitors have also been prepared.

Synchronous Machines

One of the 200,000-kva., 0.8-power factor, 1800-r.p.m. steam turbine-driven alternators (GE)[1] in the Brooklyn Edison Company's plant has been operated successfully at its rated kilowatt output, and the second unit is being installed. A 121,000-kva., 18,000-volt, 1,800-r.p.m. (AC) unit was placed in operation at Waukegan, and a 147,000-kva., 22,000-volt unit (AC) for the State Line Station is under construction. A 25,000-kva., 13,800-volt, 3,600-r.p.m. machine (W) was shipped to the Public Service Electric and Gas Company and is the largest unit yet undertaken at this speed. A 99,000-kva., 13,800-volt, 1,800-r.p.m. generator (W) is under construction for this company and is the largest unit so far built with internal fans.

Five vertical-shaft waterwheel-driven alternators rated at 48,500 kva., 13,800 volts, 25 cycles, 750 r.p.m. (CGE) are under construction for the Abitibi Cangon Development near James Bay.

A 1,250-kva., 960-cycle, single-phase generator (GE); a 1,250-kva., 1,000-cycle, single-phase generator (GE); and a 3,000-kva., 420-cycle, single-phase generator (GE) represent increases in capacity over high-frequency machines of this type built before the year 1931.

A 75,000-kva., 12,600-volt, 514-r.p.m., synchronous condenser (W) is under construction for the Commonwealth Edison Company. This is an increase of fifty per cent over the previous largest synchronous condenser.

During the year there has been considerable activity in the development of designs to improve the starting performance of industrial synchronous motors, particularly as to higher torque per kva. inrush. Several motors of 200 to 600 hp. at 300 to 900 r.p.m. have been built with a starting torque efficiency (per cent starting torque over per cent kva. inrush or unity power factor base) of the order of 55 per cent.

* COMMITTEE ON ELECTRICAL MACHINERY:

P. L. Alger, Chairman, General Electric Co., Schenectady, N. Y.,
B. L. Barns, L. F. Hickernell, E. B. Paxton,
E. S. Bundy, J. Allen Johnson, H. V. Putnam,
H. E. Edgerton, J. J. Linebaugh, K. A. Reed,
J. E. Goodale, H. C. Louis, A. M. Rossman,
T. T. Hambleton, A. M. MacCutcheon, O. E. Shirley,
A. L. Harding, O. K. Marti, R. G. Warner,
C. F. Harding, V. M. Montsinger, C. A. M. Weber,
E. W. Henderson, R. W. Owens, R. B. Williamson.
S. L. Henderson, R. H. Park,

[1] Manufacturer Designation:
AC—Allis-Chalmers Manufacturing Company
BB—American Brown Boveri Company
CGE—Canadian General Electric Company
CW—Canadian Westinghouse Co., Ltd.
ED—Electric Dynamic Company
EM—Electric Machinery Manufacturing Company
GE—General Electric Company
W—Westinghouse Electric & Manufacturing Company

Two motors for pulp grinder drive (EM) will use stator windings in four parallels, and these motors will be started by applying successively the parallel circuits all on the reduced voltage of the auto-transformer. These suitably timed increments will reduce the kva. inrush to a minimum.

The twelve 5,500-hp. motors (GE) for the U. S. Mail S.S. Company have been completed, and two ships with two motors each are in service.

The S.S. *President Hoover* (GE) and the S.S. *President Coolidge* (W) each with two 13,250-hp. motors were placed in service during the year.

Two 30,000-kilowatt frequency changers (GE) with generators rated 42,860 kva., 0.70 power factor, single-phase, 25 cycles, and motors rated 36,000 kva., 0.9 power factor, three-phase, 60 cycles, and operating at 300 r.p.m. are being installed at the Richmond Station of the Philadelphia Electric to supply power to the Pennsylvania Railroad electrification. These sets have twice the capacity of single-phase sets previously built. The generators are equivalent mechanically to 61,000-kva., three-phase machines. The frequency changers are designed for outdoor operation in steel enclosing housings.

Induction Machines

There has been considerable activity during the last year in induction machines. The demand for squirrel-cage motors for rapid and oft-repeated reversing duty, of a nature heretofore confined to d-c. mill type motors, has led to the development of special motors with low inertia rotors and liberal radiating surfaces. This demand came chiefly from the steel mill industry and concerned motors for use on furnace conveyers of the "stroke" type and motors for newly developed automatic sheet handling apparatus as used for hot finishing mills. The simple squirrel-cage motor, while it has some disadvantages as regards disposition of loss, nevertheless offers many advantages for this type of service, *e. g.*, a low-inertia, sturdy, dependable, simple, rotating element, simplified control; faster-operating control; lower-cost motor and lower-cost control. The opening up of this field to squirrel-cage motors will undoubtedly add to the wider application of this type of motor.

The use of totally enclosed fan-cooled motors has increased enormously. One company reports that over half of its induction motor production for last year was of the fan-cooled type. This type of motor is available in mounting dimensions the same as those for open motors of equal rating up to fairly large sizes, and has been well received by the trade where open type motors were subject to aggravated dirt conditions.

Selsyn motors as mediums of control formed a successful means of maintaining levels on both ends of a lift bridge on the Missouri, Kansas, Texas Ry. Other novel applications of this type of motor as a control or as an indicator are under way.

Induction frequency converters of the commutator type have, during the year, been built for use at frequencies as low as $2^1/_2$ cycles. Machines of this type with outputs at ten cycles have been supplied by a large manufacturer to increase the range of his slip-ring frequency converters. These latter, driven by a d-c. adjustable-speed motor, have a normal range of 120 to 180 cycles. By supplying 10 cycles to these converters at approximately $^1/_6$ normal voltage, the frequency range of these converters became 70 to 130 cycles, and a range of 70 to 180 cycles was made possible. These latter frequencies were used to supply small high-speed squirrel-cage motors and give them adjustable-speed characteristics for improvement in manufactured product.

Direct-Current Machines

A triple unit motor has been built (ED) for ship propulsion. One auxiliary and two main motors are placed in line with their armatures on one shaft. The auxiliary motor is designed for low cruising speed with higher efficiency than could be obtained in the main motors at low speed.

Two 2,500-hp., 282/708-r.p.m., constant-torque, induction motors have been built (AC) for driving reciprocating, 1,500-lb. per sq. in., boiler feed pumps. The Rossman system of varying speed is used. This is the first case where the d-c. armature has been mounted directly on the rotatable induction motor primary.

A 12,500-hp., 44-inch, slabbing mill drive (W) has been placed in operation. Each main roll is separately driven, without pinions, by a 5,000-hp. double-unit motor; the edging rolls by a 2,500-hp. single motor. Power is supplied by a 10,500-kw., 700-volt, d-c. set composed of one induction motor, 180,000-lb. flywheel, and three 3,500-kw. generators.

A roll grinder has been equipped (W) with nine d-c. motors for controlling separately every motion and adjustment.

Transformers

Manufacturers have given increased attention to the design of both power and distribution transformers to better withstand lightning surges and to developing methods of impulse testing to indicate weakness in transformer insulation to such surges.

Several large shell-type surge-proof power transformers (W) of the new type were built, among them units of 42,000 kva., 220 kv. which were subjected to unusually severe impulse tests, 4,500-kva. units for the Pennsylvania Railroad and a 70,000-kva. unit for the United Electric Light and Power Company, which is thought to be the largest of the self-cooled type in this country.

Self-contained features for protection against lightning independently of transformer connections or grounding practise, and for prevention of outages, were accomplished by incorporating high-voltage deion gaps and coordinated low-voltage bushings in standard distribution transformers (W).

Cover-roof type bushings are a feature of a new line of distribution transformers (AC) intended particularly for service on rural lines.

Two transformers (GE) of new design were fur-

Table I. Mercury Arc Rectifier Units Placed in Operation During 1931 or on Order December 31, 1931

Purchaser	No. of Sets	D-c. Volts	Kilowatts per Set	Total Kilowatts	Type of Control	Service	Placed in Service	Manufacturer
Amer. Gas & Elec. Co., New York	2	610	500	1,000	Automatic	Railway	1931	BB
Boston Elevated Railway	2	600	3,000	6,000	Automatic Remote Control	Railway	1931	GE
Cleveland Railway Company	x1	600	500	500	Semi-Automatic	Railway	1931	W
Clinton, Davenport & Muscatine Rwy	1*	700	500	500*	Automatic	Railway	1931	BB
Commonwealth Edison Co.	3	625	3,125	9,375	Manual	Railway	1931	BB
Commonwealth Edison Co.	1	625	2,080	2,080	Automatic	Railway	1931	BB
Commonwealth Edison Co.	1	625	3,125	3,125	Automatic	Railway	1931	BB
Commonwealth Edison Co.	1	625	3,125	3,125	Manual	Railway	1931	GE
Commonwealth Edison Co.	1	625	3,125	3,125	Manual	Railway	1931	GE
Commonwealth Edison Co.	1	625	3,125	3,125	Manual	Railway	1931	GE
Consol. Mining & Smelting Co. of Can.	1	650	6,500	6,500	Manual	Electrolytic	1931	GE
Consol. Mining & Smelting Co. of Can.	2	650	6,500	13,000	Manual	Electrolytic	1931	BB
Detroit, City of	1	600	2,000	2,000	Automatic	Railway	1931	GE
I. G. Farbenindustrie for Standard Oil Co. of Louisiana	°1	3,500/ 9,600	2,200	2,200	Manual	Electrochemical	Being erected	BB
Illinois Power & Light Company	1	650	540	540	Automatic	Railway	1931	W
Indiana Railroad Company	2	625	850	1,700	Manual	Railway	1931	BB
Long Island Railroad Company	x1	650	3,000	3,000	Automatic Remote Control	Railway	1931	W
Long Island Railroad Company	5	650	3,000	15,000	Automatic	Railway	1931	BB
Long Island Railroad Company	4	650	3,000	12,000	Automatic	Railway	On order	AC
Los Angeles Railway Corporation	2	600	1,500	3,000	Automatic Remote Control	Railway	1931	GE
Louisville Gas & Electric Co.	2	600	1,000	2,000	Automatic	Railway	1931	GE
Montreal Tramways Company	2	600	1,500	3,000	Automatic Remote Control	Railway	1931	GE
Mason City & Clear Lake Railway	1*	650	500	500*	Automatic	Railway	1931	BB
N. Y. Board of Transportation	10	625	3,000	30,000	Automatic Remote Control	Subway	1931	GE
N. Y. Board of Transportation	13	625	3,000	39,000	Automatic Remote Control	Subway	Being erected	GE
N. Y. Board of Transportation	15	625	3,000	45,000	Automatic Remote Control	Subway	On order	GE
N. Y. Board of Transportation	13	625	3,000	39,000	Automatic Remote Control	Subway	On order	GE
N. Y. Central R.R. Company	1	666	3,000	3,000	Automatic Remote Control	R.R. Electrif'n	1931	GE
Northern Indiana Pub. Service Co.	1	1,500	3,000	3,000	Automatic	Railway	1931	BB
Paris Orleans Rwy.—France	1	1,500	1,500	1,500	Automatic	R.R. Electrif'n	1931	GE
Philadelphia, City of	2	630	3,150	6,300	Manual	Railway	On order	AC
Piedmont & Northern Railway	1	1,500	750	750	Auromatic	R.R. Electrif'n	1931	W
Quebec Power Company	1	550	1,200	1,200	Automatic	Railway	1931	BB
Regina, City of	1	575	1,200	1,200	Manual	Railway	1931	BB
Sun Life Assurance Co. of Canada	2	250	400	800	Manual	Power	1931	BB
Trenton Transit Company	3	600	1,400	4,200	Manual	Railway	1931	BB

* In addition, one spare rectifier (without transformer) was supplied.
x Temporary installation.
° Also reported 1930.

Totals*	1931		1930	
	No. of Sets	Kilowatts	No. of Sets	Kilowatts
Placed in service	57	127,845	33	75,225
Being installed	14	41,200	26	71,400
On order	34	102,300	29	79,275
Grand total for year	105	271,345	88	225,900
Total number units in service, Dec. 31st	180	305,379	123	177,534

* Spare rectifier tanks without transformers not included.

nished to operate an X-ray tube for cancer research in the California Institute of Technology. Each unit is rated 0.03 ampere at 700,000 volts to ground continuously, and operates in series with mid-point grounded, giving 1,400,000 volts effective at the X-ray tube.

Magnetic oil level indicators were made available (GE and AC) for power, large distribution, and high-voltage instrument transformers. This gage has numerous advantages over a glass oil gage because it is more easily read, and more easily maintained oil tight. It has no glass to become dirty on the inside or break and allow oil to run out.

The number and capacity of load-ratio control transformers exceeded all previous records. The development of a design (GE) suitable for lower-rated circuits up to 15,000 volts, single-phase or three-phase, resulted in an economical application of load-ratio control to distribution transformer sizes. This type of equipment was applied to the new three-phase 1,500-kva. transformers for high-voltage networks. A new line of standard tap changers (W) using standard parts suitable for wide range of capacities as low as 200 kva. were completed.

A new type of inertaire protection for power transformers (W) using nitrogen from a gas cylinder was perfected. A uni-directional breather (AC) for use on power transformers, which induces a natural circulation of air over the oil in the main transformer tank or expansion tank to reduce condensation and carry off condensed moisture was developed.

Mercury-Arc Rectifiers

The use of rectifiers has continued to expand during the year as indicated by information contained in Table I.

The large number of additional 3,000-kw. 625-volt units ordered by the New York Board of Transportation is the outstanding feature of this year. Twenty-three of these rectifiers were ordered last year and 28 this year, making a total of 51 sets (GE) with a total capacity of 151,000 kw.

The three 6500-kw. 650-volt electrolytic rectifiers listed in this and last year's report were placed in service during the year.

A 3,000-kw. 650-volt sectional rectifier (W), consisting of four 750-kw. separate rectifiers arranged in a compact unit, was developed and placed in service.

The first complete portable mercury-arc rectifier substation, consisting of a 540-kw., 650-volt (W) rectifier with transformer and control, cooling system, car, etc., was placed in service by the Illinois Power & Light Company.

Protective Devices

ANNUAL REPORT OF THE COMMITTEE ON PROTECTIVE DEVICES*

THE work of the Committee on Protective Devices during the past year was handled largely through subcommittees as has been the practise for several years. These subcommittees are listed below together with their chairmen:

Relays	O. C. Traver
Oil Circuit Breakers, Switches, and Fuses	T. G. LeClair[1]
Lightning Arresters	H. K. Sels
Fault Current Limiting Devices	R. T. Henry
Interconnections[2]	F. C. Hanker

General

The committee continued its activities in following the preparation of standards, and review of research and development, although the main activity during the year was fostering the preparation and presentation of papers before the Institute.

While the technical achievement during the year is very satisfactory in view of the general business conditions, these conditions of course had a depressing effect on research and developmental activities. Progress in this respect consisted largely of refinements and extensions of fundamentals previously established.

Difficulty in securing agreement relative to certain matters concerning the standards for fuses and the revised standards for disconnecting, horn-gap and knife switches has prevented completing these standards. Plans have been made for a course of action which it is believed will permit of putting these standards into report form. Every effort is being made to place these standards in such shape that complete agreement may be secured which will permit their adoption as Institute Standards.

Relays

Report of Subcommittee

The development of high-speed relays continued, resulting in marked improvements to primary power-system relays generally, and in new developments in the a-c. railway and secondary distribution network system fields.

One of the manufacturers has developed so-called straight-line relays, particularly for application on 4,000-volt networks which are capable of discriminating and operating on very small differences in current, although these currents may be quite heavy.

An important advance during the year was the redesign of all types of relays by at least one manufacturer in order to accommodate the relays in a new universal case, with standard stud arrangement, which is being used to a large extent for front of panel switchboard devices.

A high-speed current differential relay for transformer protection having an operating speed of 0.004 second has been developed.

Numerous refinements in mechanical details contributing to the reliability and accuracy of relays of all types have been carried forward.

Completed developments in coupling and protective equipment for all carrier-current applications include cable-type coupling-capacitor assemblies for all voltages from 115 to 230 kv., inclusive.

In order to secure a consensus of present day practise in regard to protection of apparatus of all classes, a questionnaire on this subject has been sent to a number of engineers, and a number of replies has already been received.

An important advance in relay application during the past year has been the wide increase in the use of the method of symmetrical components for determination of not only the fault current but also the voltage and current at the relay location, particularly for distance relay applications.

The following papers appearing under the auspices of the committee have been presented before the Institute:

A New High-Speed Distance Relay, S. L. Goldsborough and W. A. Lewis, Westinghouse Electric & Manufacturing Co.

Application of High-Speed Relays, G. W. Gerrell, Union Electric Light & Power Co.

A New High-Speed Distance Relay, A. R. Van C. Warrington, General Electric Co.

Relay Operation From Bushing Potential Devices, P. O. Langguth, Westinghouse Electric & Manufacturing Co., and V. B. Jones.

Operation of Relays From Carrier-Current Coupling Capacitors and Capacitance Transformer Bushings, J. E. Clem and R. E. Cordray, General Electric Co.

Effect of Wave Form on Operation of Induction Relays, P. H. Robinson, Houston Lighting & Power Co.

A Telegraphic Pilot-Wire Relay System, C. H. Frier, Oklahoma Gas & Electric Co.

Oil Circuit Breakers, Switches, and Fuses

Report of Subcommittee

Intense interest has been shown during the year in the fundamental theories underlying the various circuit breaker developments of the last few years. These discussions have resulted in clarifying concep-

* COMMITTEE ON PROTECTIVE DEVICES:

Raymond Bailey, Chairman,
L. P. Hickernell, Vice-chairman,

H. W. Collins,	T. G. LeClair	H. P. Sleeper,
A. W. Copley,	J. B. MacNeill,	L. G. Smith,
W. S. Edsall,	J. P. McKearin,	E. R. Stauffacher,
L. E. Frost,	H. A. McLaughlin,	H. R. Summerhayes,
S. L. Goldsborough,	D. M. Petty,	O. C. Traver,
R. T. Henry,	H. J. Scholz,	E. M. Wood,
E. A. Hester,	H. K. Sels,	H. B Wood.

[1] Mr. LeClair was appointed chairman of the subcommittee on oil circuit breakers, switches, and fusee on January 4, 1932, when Mr. Hickernell resigned as chairman of this subcommittee.

[2] The interconnections subcommittee is a joint subcommittee having representation from the following committees: Protective Devices, Power Generation, Transmission and Distribution, Electric Machinery.

tions of the theories on which these new types of breakers operate and has laid ground work for further development in the future. The amount of fundamental development which this intensive scrutiny reveals will, if supported by satisfactory performance records, do much to increase the confidence of the user in the ability of oil circuit breakers to perform adequately.

The metal-clad switchgear has been improved in a number of details and the development has been extended to interrupting ratings of 500,000 kva. at 15 kv. for indoor breakers and to 1,500,000 kva. at 132 kv. for outdoor breakers.

The oil-blast and deion grid principles of breaker construction were extended to quite high ratings, and both types have appeared in the metal-clad construction. Elaborate tests on a 1,500-ampere 15-kv. high-speed deion circuit breaker were performed for a railway application. Seventy-two short circuits ranging from 2,720 amperes to 50,500 amperes were thrown on the breaker in about five hours time. Some of these short circuits lasted only 0.024 second and the duration of the longer ones was 0.04 second. A series of fifty tests at current values from 11,000 to 49,000 amperes was run on impulse type of oil-blast breaker of a corresponding rating. This breaker clears the circuit in 0.04 second or less over the full current range.

Developments in air circuit breakers include extension of current ratings and improvements in operating speed.

The fuse manufacturers have been active in the development of improved type fuses, which are more economical.

There is a fairly widespread feeling among operating engineers in particular that some improvement could be made on the basis of rating of oil circuit breakers.

The following papers appeared under the auspices of the committee and have been presented before the Institute:

The Theory of Oil-Blast Circuit Breakers, D. C. Prince, General Electric Co.

The Practical Application of the Oil-Blast Principle of Circuit Interruption, R. M. Spurck, General Electric Co.

Recent Developments in Arc Rupturing Devices, R. C. Van Sickle and W. M. Leeds, Westinghouse Electric & Manufacturing Co.

The Extinction of Alternating Current Arcs in Turbulent Gases, T. E. Browne, Jr., Westinghouse Electric & Manufacturing Co.

Application of Primary Distribution Fuses, F. E. Sanford, Union Gas & Electric Company.

The Expulsion Fuse, J. Slepian and C. L. Denault, Westinghouse Electric & Manufacturing Co.

Fuse Cut-Outs—Their Design and Application for A-C. Distribution Circuits, E. G. Newton, General Electric Co.

The Boric Acid Fuse, A. P. Strom and H. L. Rawlins, Westinghouse Electric & Manufacturing Co.

Fault Current Limiting Devices

Report of Subcommittee

The committee is not aware of any developments relating to fault current limiting devices of sufficient importance to warrant including in this report. Operating experience with such devices apparently continues to be quite satisfactory, and the need for further development is therefore not particularly urgent.

Lightning Arresters

Report of Subcommittee

As in other lines, the developments on lightning arresters consist principally of extensions of recently developed, fundamental theories to a greater variety of forms of station and line type arresters; also, a marked improvement has been made in the mechanical design and construction of lightning arresters which will improve the maintenance of their electrical characteristics.

Studies of lightning and the effects of lightning on power systems were continued during the year with considerable improvement in the technic of fault location. Newly developed lightning current meters and special low resistors were used to measure the current in the lightning stroke.

Continued field investigations using portable surge generators and cathode ray oscillographs, were made in conjunction with study of applications of lightning arresters to distribution transformer installations and associated line construction.

Considerable experimental work concerning grounds and ground connections resulted in making available information which may be used to improve the effectiveness of lightning arrester applications.

New protective devices have been developed, arranged for installation inside of the distribution transformer. This development marks a new phase in the problem of protection of transformers against the effects of lightning and should result in very much improved operating experience.

A report is in preparation jointly with the N.E.L.A. Subject Committee on Lightning Arresters, outlining the prevailing practise on the installation, operation, and experience of various types of lightning arresters by a number of the larger operating companies. This information should be valuable in observing the present trend of operating practise on transmission and distribution systems relative to arrester installation, operation, and performance as affecting suitable standards, and also whether tests and equipment should be developed to determine the operating condition of arresters in service.

Lightning arrester manufacturers have contributed largely to the development of more powerful testing equipment and more accurate recording apparatus which has been used to carry out the proposed tests outlined in the Report on Standards for Lightning Arresters and has effectively demonstrated the value

of these tests to determine the characteristics of lightning arresters.

The report on Standards for Lightning Arresters continues in its tentative form and it will probably not be feasible to revise this report until work now in progress on the characteristics and coordination of system insulation with respect to lightning has progressed further.

Interconnections

Report of Joint Subcommittee

The Joint Subcommittee on Interconnections includes representatives of the Protective Devices, Power Generation, Transmission and Distribution, and the Electric Machinery Committees.

At the Winter Convention 1932 the session under the auspices of the subcommittee included two subjects of particular interest to the Protective Devices Committee, namely, the "Report of the Subject Committee on Definitions of Terms Used in Power System Studies" and the papers presenting revised decrement curves.

The activity of various engineering groups in studies of interconnection has built up a terminology for which there has been no official recognition. A Subject Committee has been at work on these definitions for some time and presented a report that will be used as the basis for the consideration of such definitions by the responsible standardizing bodies. A large number of these definitions is related to subjects of interest to the Protective Devices Committee.

The papers on decrement curves and short circuit calculations are:

I—Standard Decrement Curves, W. C. Hahn, General Electric Co. and C. F. Wagner, Westinghouse Electric & Manufacturing Co.

II—Calculation of Short Circuits on Power Systems, C. F. Wagner, Westinghouse Electric & Manufacturing Co., and S. H. Wright, Buffalo, Niagara & Eastern Power Corporation.

III—Decrement Curves for Specific Systems, W. C. Hahn, General Electric Co.

During 1918, Messrs. Burnham, Hewlitt, and Mahoney discussed decrement curves for relay and circuit breaker applications before the Institute. The group of papers presented at the last Winter Convention brings the subject up to date, utilizing the further knowledge of machine characteristics accumulated in the intervening period.

Instruments and Measurements

ANNUAL REPORT OF COMMITTEE ON INSTRUMENTS AND MEASUREMENTS*

THE Committee on Instruments and Measurements during the year 1931–32 has had an active membership of 23 members. At the meeting held in October 15 members were in attendance, and at the meeting held in January 13 members attended. Considering the geographical distribution of the membership, this attendance is exceptionally good.

The work has been organized through subcommittees to take care of the following subjects:

1. Recording instruments
2. Telemetering
3. Definitions of instruments and testing
4. Instrument transformers
5. Indicating instruments
6. Temperature measurements
7. High-frequency measurements

Subcommittee on Recording Instruments

This subcommittee has been engaged for several years on the development of standards for recording instruments. During the year its work was completed and a draft of the proposed standards was approved by the Instruments and Measurements Committee. These have been forwarded to the Secretary of the Standards Committee for adoption and publication. This subcommittee has been under the chairmanship of Mr. Kinnard and is to be complimented on the completion of a task which involved such a large amount of painstaking work.

Subcommittee on Telemetering

This subcommittee has concluded its work on standard definitions which have been approved by the Instruments and Measurements Committee. These have been submitted to the Secretary of the Standards Committee.

In addition to its work of following developments in this field, it has undertaken to cooperate with a subcommittee of the Automatic Stations Committee in the preparation of a report on telemetering and supervisory control systems and related communication systems. This report is a very comprehensive survey of all the known telemetering systems, which have been critically analyzed so as to provide detailed information in regard to the limitations and operating characteristics of each. It is hoped to have this report for the Summer Convention. Mr. E. D. Doyle is chairman of this subcommittee.

* COMMITTEE ON INSTRUMENTS AND MEASUREMENTS:

E. J. Rutan, Chairman,
H. S. Baker, R. D. Bean, O. J. Bliss, P. A. Borden, H. B. Brooks, A. L. Cook, E. D. Doyle, W. W. Eberhard, Marion Eppley, J. B. Gibbs, W. N. Goodwin, Jr., I. F. Kinnard, O. A. Knopp, A. E. Knowlton, H. C. Koenig, W. B. Kouwenhoven, F. A. Laws, E. S. Lee, J. B. Lunsford, Paul MacGahan, R. T. Pierce, W. J. Shackelton, H. L. Thomson, H. M. Turner.

Subcommittee on Definitions of Instruments and Testing

This subcommittee is an outgrowth of the co-operation of the Instruments and Measurements Committee with the Sectional Committee of the American Standards Association which is preparing definitions on instruments and testing. Mr. E. S. Lee as chairman of this subcommittee has been assisted by the chairmen of the Recording Instruments, Telemetering, Instrument Transformers, and Indicating Instruments subcommittees as well as all of the members of the Instruments and Measurements Committee. Many valuable suggestions and considerable work has been done in the criticism, correction, and re-arrangement of several of the drafts of definitions submitted to this subcommittee. Joint meetings were arranged with the members of the Sectional Committee and, as a result, an acceptable draft of these definitions has been completed.

Subcommittee on Instrument Transformers

The Subcommittee on Instrument Transformers has been active for the past two years in the revision of standards No. 14 and has about completed its work and is preparing to submit a final draft of these standards to the members of the Instruments and Measurements Committee. Mr. J. B. Gibbs is chairman of this subcommittee.

Subcommittee on Indicating Instruments

Indicating instruments standards No. 23 which have been available to the industry since 1927 have been under consideration for revision during the past year. Based on considerable progress in the art since the standards were issued and the experience of the Instruments and Measurements Committee, many desirable changes will be made and new data incorporated in these standards. An early report from this subcommittee is expected which, upon approval by the Instruments and Measurements Committee, will be forwarded to the Standards Committee. Mr. H. C. Koenig is chairman of this subcommittee.

Subcommittee on Temperature Measurements

This subcommittee, which is under the chairmanship of Mr. H. C. Koenig, has been working on the preparation of a standard code for temperature measurements. The scope of this work is to cover all the requirements of temperature measurements as specified in the various standards of the Institute. It is expected, when completed, a very comprehensive procedure will be available for uniform measurements of temperature.

Subcommittee on High-Frequency Measurements

This subcommittee has been active under the chairmanship of Prof. H. M. Turner. Arrangements were made to cooperate with a committee appointed by the Standards Committee to draft definitions and standards for sound measurements. The subcommittee is also making a study of vacuum tube voltmeters and will prepare a report on this subject during the coming year.

Institute Sessions and Papers

In addition to the Committee work through its subcommittees on definite subjects, arrangements were made for the promotion of a session at the Mid-Winter Convention. Six papers were presented and are listed below:

1. *High Voltage Bridge for Measurements of Cable with Grounded Sheaths*, C. L. Dawes and A. F. Daniel.
2. *A High Sensitivity Power Factor Bridge*, W. B. Kouwenhoven and Alfredo Banos, Jr.
3. *Capacitance and Power Factor Measurement by the Capacitance Bridge*, R. P. Siskind.
4. *An Automatic Oscillograph*, C. M. Hathaway and R. C. Buell.
5. *The Photoelectric Recorder*, C. W. La Pierre.
6. *Aging and Elastic Hysteresis in Instrument Springs*, P. MacGahan and R. W. Carson.

In addition to the papers presented at the session, the following papers were reviewed by the various members of the Instruments and Measurements Committee and commented upon:

1. *The Metering of Symmetrical Components*, G. R. Shuck.
2. *Electrical Measurements of Sound Absorption*, A. L. Albert and W. R. Bullis.
3. *Electrical Solutions of Problems of Regular Scheduled Flight*, C. F. Green.
4. *The Photoelectric Recorder*, C. W. La Pierre.
5. *A Standard of Low Power Factor*, W. B. Kouwenhoven.
6. *Electrical Measurements in the Gas Industry*, E. X. Schmidt.
7. *A Special Application of the Potentiometer Principle*, J. L. Watson and R. C. Gleeson.
8. *A Bridge for Precision Power Factor Measurements on Small Oil Samples*, J. C. Balsbaugh and P. H. Moon.
9. *Skin Effect in Rectangular Conductors*, H. C. Forbes and L. J. Gorman.

Conclusion

The Chairman wishes to acknowledge at the completion of his two years of office the hearty co-operation of all of the members of the Instruments and Measurements Committee. The work of the vice-chairman, secretary, and chairmen of the subcommittees was of especial importance in the successful completion of many of the projects which we had before us. From several years contact with this committee as a member and as chairman, the writer has been very much impressed by the interest displayed, and feels highly confident concerning the continued activity in this field of the electrical engineering art as sponsored by this committee.

Transportation

ANNUAL REPORT OF THE COMMITTEE ON TRANSPORTATION*

Railroad Electrification

THE Reading Company began operation on July 26, 1931, of the first portion of its electrified suburban service running out of Philadelphia. Multiple-unit cars are now operated over 64.6 miles of route embracing 156.9 track miles and the electrification of two more branches is in progress, the completion of which will bring the total electrified mileage to 86.9 route miles or 203 track miles. Single-phase, 25-cycle, alternating current is supplied by the Philadelphia Electric Company through outdoor frequency changer sets located on the railroad's property at Wayne Junction, and is distributed to the trains over a 36,000/12,000 three-wire system with 12,000 volts between the overhead contact wires and the rails, and 24,000 volts between the rails and the feeders carried on the catenary structures. Provision has been made on these structures for supporting transmission lines of higher voltage when future extensions of the electrification make it necessary. Over a part of the right-of-way steel towers are to be used jointly by the power company for high-voltage transmission and by the railroad for supporting its catenary system. All of the power switching is handled from a single supervisory control board at Wayne Junction, at which point also are located the repair shops and storage yards for the car equipment.

The Pennsylvania Railroad Company has made very considerable progress on its project for complete electrification between New York and Washington. The overhead contact system has been installed in the New York Terminal zone between Sunnyside Yards on Long Island and Manhattan Transfer in New Jersey, where d-c. third-rail locomotives have been used hitherto, and a-c. locomotives are now handling some of the trains. Construction is progressing between Manhattan Transfer and Trenton, New Jersey, the completion of which, in association with the work already done, will permit electric operation from New York as far as Wilmington. The erection of catenary structures between Wilmington and Washington has been begun. Several locomotives of the new standard designs have been placed in service. The motors on the two types of passenger locomotives (2-B-2 and 2-C-2) and the road freight locomotive (1-D-1) have interchangeable armatures, stators, and other parts, those on the passenger engines being mounted in twin frames, a pair for each driving axle, while those on the freight locomotive are mounted independently one on each of the four driving axles. The motors all have a continuous rating of 625 hp. per armature. Standardization and interchangeability of parts have been carried out as far as possible throughout the design of these locomotives, both in the mechanical parts and in the electrical equipment. These standard motive power units may be operated in various combinations to provide the tractive effort required for different classes and weights of trains.

The New York Central Railroad has eliminated the use of steam locomotives on its "West Side" line in New York City, full operation by either electric or oil-electric locomotives having been inaugurated in June 1931. Third rails supplying direct current at 650 volts have been installed as far south as 72nd Street, but only to a very small extent in the yards between 72nd and 60th Streets. No external power supply has as yet been provided on the tracks which lead (still largely on the city streets) to the smaller yards and terminals further downtown. The locomotives which handle the switching and transfer work in this territory have oil engine-generator sets and storage batteries to provide their own power, but are also equipped to receive power from the third rail where it is available.

The New York, New Haven & Hartford Railroad has placed in operation the ten new passenger locomotives mentioned in last year's report. They weigh 403,000 lb. and have the axle arrangement 2−C+C−2 with a weight on drivers of 45,600 lb. per axle. Each of the six driving axles is connected by quill and gear to a twin motor with a continuous rating of 550 hp. These locomotives are notable for improved motor design, giving better commutation and increased tractive effort.

Oil-electric locomotives, as well as oil-electric and gasoline-electric rail motor cars, are finding an increasing number of applications. Seven such locomotives recently placed in service by the Bush Terminal Company in Brooklyn, New York, are unique in that their cabs, underframes, and trucks were fabricated entirely from structural shapes and plates, with electric welding and no riveting.

Air conditioning on passenger cars and experiments with rubber-tired rail cars are among recent developments in railroading which contain elements of interest to the electrical engineer.

Railroad Signaling

A number of additional installations of the recently developed methods of centralized traffic control was made during the past year. These, together with the completion of many new interlocking plants, automatic signals, highway crossing signals, and car retarders kept the record of progress in the installation of signaling facilities up to about 65 per cent of that in the previous year in spite of the reduction in the volume of construction in general.

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Urban Transportation

The New York City Board of Transportation has practically completed the equipment of the new Eighth Avenue Subway from Fulton Street to 207th Street, Manhattan, and has received 300 cars which have been tested in trial runs and are ready for the beginning of operation. Five hundred more cars have been ordered in preparation for extension of the service to other sections of the new system which are under construction in the boroughs of Brooklyn, Queens, and the Bronx. The substation equipment for these lines will include 16 converters in five substations with an aggregate capacity of 53,000 kw., and 62 mercury arc rectifiers rated at 3,000 kilowatts each, most of which will be placed in individual subterranean compartments along the subway lines.

Systematic efforts are being continued to design a type of street car which will more successfully meet the competition of the buses and the private automobiles. The tendencies are toward the use of lightweight, double-truck cars, with small wheels and low floors, equipped with small high-speed motors giving rapid acceleration and high car speeds. Control has been improved by the use of a larger number of resistance steps and also by the introduction of "variable-automatic control" in which the operation of the resistance contactors is governed by relays, but the motorman can select the rate of acceleration according to traffic or rail conditions. Braking by means of electromagnetized shoes on the car acting against the running rails is being used to some extent. Higher speed and lighter weight are the tendencies in interurban cars also, and some attention is being given to improvement in body design to reduce wind resistance.

The use of trolley buses is being extended, such vehicles having been purchased for seven cities during 1931, at the end of which year there were 225 trolley buses in operation in 14 cities in the United States.

Marine Transportation

The two largest passenger liners built in the United States, the *President Hoover* and the *President Coolidge*, were placed in operation during the past year in intercoastal and transpacific services. Each of these twin ships has two 10,000-kw. turbine-driven generators which supply the synchronous-induction propulsion motors with three-phase, alternating current at 4800 volts, and also four 500-kw. turbine-driven d-c. generators which very completely serve the auxiliary equipment on board, including steering gear, winches, capstans, air compressors, refrigerating machines, blowers, pumps of all sorts, elevators, cooking equipment, stateroom heaters, fans, etc., in addition, of course, to searchlights and general lighting. Several other smaller motor-propelled vessels with generators driven by steam turbines or oil or gasoline engines were placed in commission during the year. (See also the report of the Committee on Applications to Marine Work.)

Aerial Transportation

The U.S. Navy dirigible *Akron* carries considerable electrical equipment, including a searchlight and general lighting, cooking appliances, radio equipment, a battery charging set and other motors. The energy is supplied by two 11-kw., 115-volt d-c. generators driven by gasoline engines. The huge mooring mast, by which the dirigible is towed into and out of its hangar at Lakehurst, N. J., is propelled by two caterpillar tractors driven by 125-hp., 250-volt, d-c. motors and is steered by a third caterpillar driven by an 8-hp. motor. A 240-hp. gasoline-driven generator supplies these motors as well as floodlights and signaling apparatus on the mast and equipment for conveying water, fuel, and electricity to the dirigible.

A novel type of electric locomotive is used to tow models of sea-plane hulls or pontoons in a testing channel 2,000 ft. long, 22 ft. wide, and 12 ft. deep, recently completed at Langley Field, Va. The towing car spans the tank and is driven by four 75-hp. motors. The remarkable feature is its rapid acceleration, as it is said to reach a speed of 60 miles an hour in 9 seconds.

Important improvements were made during the year in radio equipment for communication between airplanes and the ground and for direction finding. These include automatic volume control, which relieves the pilot of the necessity of making manual adjustment of receiver amplification over a wide range of distances, and also practicable means of giving visual indication in connection with the direction finders.

Among electrical devices perfected for application to aviation may be mentioned an instrument for indicating engine cylinder temperature which is so calibrated and compensated as to show directly in degrees the temperature of various parts of the engine where thermocouples are installed. The leads from several thermocouples are brought to the indicator through a selector switch. Another device is the sonic altimeter in which a compressed air whistle produces signals electrically timed and controlled, which are reflected from the ground. The echo is heard in a stethoscope and, by means of a timing indicator mounted on the instrument panel, the time interval between outgoing and returning signals is interpreted directly in terms of distance above the ground.

Vertical Transportation

The opening of the Empire State Building in New York City in 1931 placed in service the largest installation of elevators yet made. These are all of the automatic type and those serving the upper part of the tower have higher speeds and longer vertical travel than any previously installed. Improvements in construction and in the control of emergency stopping devices now permit speeds up to 1200 ft. per minute.

An installation of double-deck elevators, serving two floors simultaneously, has been made in the

tower of the new Cities Service Building in New York City. In this same structure there is also the first installation of escalators in an office building, a means of transportation which is being used more and more extensively in department stores, railway stations, etc.

The arrangement, mentioned in last year's report, in which two independent elevators are operated in the same shaft, one running express to the upper floors and the other serving the lower floors, with suitable safety interlocking, appears to be a thoroughly practical development. Such elevators are in service in one of the Westinghouse buildings in East Pittsburgh.

Applications to Marine Work

ANNUAL REPORT OF COMMITTEE ON APPLICATIONS TO MARINE WORK*

AS in the past few years, the major items of activity of the committee have been:

1. Accumulating, as a result of experience, data for revision of Standards No. 45, Recommended Practise for Electrical Installations on Shipboard.

2. Promoting the idea of establishing a definite status of the electrical operating personnel on shipboard.

3. Following closely installations of electric propulsion and electrification of auxiliaries on shipboard.

Standards No. 45

These standards are proving to be more and more useful to naval architects, shipbuilders, ship operators, and manufacturers of electrically driven auxiliaries. As a result of this increase in use, it is natural that changes and additions should be found desirable. During the past year the committee has continued to collect data for such revisions and when the volume of this data seems to justify a reissue of the standards, the committee expects to recommend such action to the Institute.

Operating Personnel

For some years the committee has felt it important that the personnel in charge of the electrical machinery on ships should have a more definite status than is now in vogue. With the increasing use of electricity for both propulsion and auxiliaries, the necessity for such a recognized status has become more urgent. Our first efforts were based upon improving the status of electrical operating personnel through governmental channels, but as a result of experience, it has become apparent that our efforts will probably meet with more success if we cooperate with the owners and operators of vessels to this end; hence, during the past year we have been in further conferences with the American Steamship Owners Association and we believe that we are about to arrive at such a working agreement with this association as will lead to definite results.

Electric Propulsion and Auxiliaries

As stated in last year's report, the year 1930 was one of great activity, progress and accomplishment in marine engineering, generally. This was due largely to the passage of the Jones-White Merchant Marine Act in 1928. This activity resulted in contracts being let for a large number of ships with electric propulsion and auxiliaries.

Due to the present financial depression the past year has not been marked by such activity, but the program started the year before has continued to be executed without cancelation of contracts.

The following table shows the status during the year of new ships in the U.S.A. equipped with electric propulsion:

Ships Commissioned in the U.S.A. During 1931

Turbine Electric Drive

Name	Type	Horsepower
PRESIDENT HOOVER	Passenger Cargo	26,500
PRESIDENT COOLIDGE	Passenger Cargo	26,500
TALAMANCA	Passenger Cargo	10,500
CAYUGA	Coast Guard Cutter	3,220
SHOSHONE	Coast Guard Cutter	3,220
	Total	69,940

Diesel Electric Drive

Name	Type	Horsepower
COLUMBINE	Lighthouse Tender	240
LINDEN	Lighthouse Tender	240
GULF MIST	Tanker	400
WHITE FLASH	Tanker	375
SAN DIEGO	Ferry	750
DUPLEX	Dredge	600
	Total	2,605

Ships Under Construction in the U.S.A. During 1931

Turbine Electric Drive

Name	Type	Horsepower
*SEGOVIA**	Passenger Cargo	10,500
CHIRIQUI	Passenger Cargo	10,500
ANTIGUA	Passenger Cargo	10,500
QUIRIGUA	Passenger Cargo	10,500
VERAGUA	Passenger Cargo	10,500
	Total	52,500

* Destroyed by fire Dec. 1931.

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H. L. Hibbard. H. M. Southgate. W. N. Zippler.

Diesel Electric Drive

Name	Type	Horsepower
———	3 Tugs	1,600
———	1 Yacht	600
	Total	2,200

Gasoline Electric Drive

Name	Type	Horsepower
JOHN T. HARVEY	Fireboat	2,130

Production and Application of Light

ANNUAL REPORT OF THE COMMITTEE ON PRODUCTION AND APPLICATION OF LIGHT*

Production of Light

Statistics on Lighting Progress as Indicated by Incandescent Lamp Sales

THE production and use of artificial light, as indicated by the sale of incandescent lamps, decreased slightly during 1931 as compared with previous years. In actual numbers of lamps sold the decrease was not great. The average wattage decreased from 61.2 to 60.9 watts, lamp efficiency from 13.3 to 13.4 lumens per watt and average lumens from 814 to 817.

The continued increase in the use of 120 volts for lighting circuits is notable. The percentage of 120-volt lamps sold increased from 41.3 per cent in 1930 to 43.9 per cent in 1931, while 110- and 115-volt lamps decreased from 5.2 per cent to 3.7 per cent and 48.9 per cent to 48.0 per cent, respectively. The adoption of the three-phase four-wire network system of distribution is probably the major factor influencing this trend.

Street lighting continues to show an increase both in the number of lamps used and in the average light output.

New Incandescent Lamps

Photoflood Lamps

A companion lamp for the photoflash lamp has been developed—the photoflood lamp. The photoflash lamp is intended for use in making snapshots, while the photoflood lamp is intended for time-exposures and for home or amateur motion picture photography. The new lamp has a bulb of the same size and shape as the standard 60-watt lamp but is rated at 250 watts and operates at an extremely high efficiency. In light output it is equivalent to a standard 500-watt lamp but in photographic effect, due to a high percentage of actinic light, it compares with a 750-watt lamp.

Neon-Filled Christmas Tree Lamps

Christmas trees are illuminated usually by strings of eight 15-volt lamps burning in series. The failure of one extinguishes the entire string and it is necessary to try each successive lamp in the string until the burned-out lamp is located. Neon-filled lamps have been developed which operate in the usual manner until one fails. This impresses the full line voltage across that particular lamp and causes it to glow with the characteristic neon red. As the current producing the glow is not sufficient to light the remaining lamps, the burned-out lamp is identified readily.

Inside Frosting 150 to 500-Watt Lamps

The inside frosted finish has been made available for lamps of 150 to 500 watts. This finish is desirable for lamps used in light density enclosing globes and in indirect lighting units since it diffuses the light and eliminates sharp shadows.

Addition of 1,500-Watt Lamps

Increasing use of high intensity illumination produced a demand for 1,500-watt lamps sufficient to warrant their inclusion in the regular lamp schedules.

Elimination of 600- and 800-Lumen Lamps

Authorities on street lighting practise consider the use of lamps of less than 1,000 lumens output inadvisable. The 600- and 800-lumen, 6.6-ampere lamps have been removed, therefore, from the regular schedules.

Imported Incandescent Lamps

Electric lighting in America has enjoyed a favorable lamp situation in that a great majority of the lamps supplied to the public have been of well-controlled quality and of highest practicable efficiency. This condition is threatened now with impairment due to the advent of inferior lamps. Notable among these are lamps imported from Japan and sold through irregular channels of distribution. The Committee is informed that aside from miniature

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lamps, about twenty millions of Japanese lamps were imported during the last year. These were characteristically of such low efficiency that at prevailing rates for current the public could not afford to use them.* Defects which interfere with satisfactory service were unduly prevalent among them and their life performance was very irregular and inconsistent.

In drawing attention to this development, the Committee bespeaks cooperation of electrical engineers generally in doing all that may be practicable to prevent the impairment of American lighting by lamps of inferior quality.

Base and Socket Standardization

At the present time the screw bases and sockets standard in Europe differ slightly from the original American Edison standard in such a way that American lamps are not assured of fitting in European sockets, but European lamps can be put in American sockets, though failing to meet American safety requirements. Although many more American sockets and bases are in actual use, it was proposed to adopt the European design as the international standard. At a meeting of the International Electrotechnical Commission's Committee, held concurrently with the 1931 sessions of the International Commission on Illumination, the American standards were recommended on a par with the European and plans were advanced looking toward a single universal standard of intermediate dimensions.

Proper Operating Voltage

The voltage at which incandescent lamps are operated affects their input, output, efficiency, rate of depreciation, and cost of producing light to such an extent that it cannot be overlooked in any consideration of the production and application of light involving such sources.

The N.E.L.A. Lamp Committee Report for 1930–31* contains a study of operating voltages in use in some 24,590 communities. The detailed figures presented in the report reveal an undesirable tendency toward the increased use of more than one standard voltage in individual communities. Such dual standards make it difficult, if not impossible, to insure that lamps of proper voltage are used. During the five-year period from 1923 to 1928 there was a marked reduction (13.2 per cent to 5.4 per cent) in the extent to which two lighting service voltages were used by any one community, but in the last years this has increased again.

Wiring Specification

Of the specifications mentioned in last year's report, the "Minimum Specification for Wiring of Lighting Circuits in Industrial Structures" was issued during the summer.

Regarding residence wiring, several associations undertook independently the development of specifications. An industry committee was organized to coordinate the work and prepare amplified specifications acceptable to all groups. This work is reported now to be complete, subject to final approval by the several associations. It is understood that the proposed specification sets No. 12 wire as the smallest size to be recommended for any lighting circuit. This limitation, corresponding as it does to that of the commercial and industrial specifications, should help eliminate smaller sized wire from good standing with the designers of electric light wiring, and thus advance good engineering in this field.

Carbon Arcs

Recent careful control tests of various sources of illumination with respect to their speed and color reproduction in photography have shown that the white flame photographic carbon almost exactly duplicates the results obtained with natural sunlight

* *Transactions*, Illuminating Engineering Society, November 1931.

* N.E.L.A. Bulletin—Sept. 1931, p. 627.

Table I—Data on Incandescent Type of Ultra-Violet Sources

Source	Type S-1	Type S-2	Type G-1 Lamp	CX Lamps		
				60-watt	300-watt	500-watt
Approximate lamp watts	400	130	36	60	3000	500
Approximate total watts with auxiliaries	500	175	50	60	300	500
Approximate transformer primary amperes	9	3	1			
Approximate operating volts	14–15	15	18–20	110–115–120*	110–115–120*	110–115–120*
Approximate operating amperes	27.5	8.5	2	0.5	2.6	4.3
Approximate lumens	8400	1850	150	785	6000	10,750
Approximate lumens per watt (lamp)	21	14.2	3.7	13.1	20	21.5
Approximate over-all lumens per watt	16.8	10.5	3.0	13.1	20	21.5
Bulb	PS-22 inside frosted	A-17 clear	A-21 inside frosted	A-21 inside frosted	PS-30 inside frosted	G-38 inside frosted
Base	Mogul screw	Special screw	Medium screw	Medium screw	Mogul screw	Mogul screw
Maximum over-all length—inches	6⅞	4⅞	4¼	4 13/16	7⅛	7⅝
Light center length—inches	5	3¼	2¼**	3¼	5	5
Foot-candle minutes for MPE	3500	6500	1300†	175,000†	120,000	100,000
Approximate life—hours	400	400	500	500	500	500
List price	$7.50	$3.75	$3.50	$1.00	$3.00	$3.50

N. B. Burning the Types S-1 and S-2 lamps at an angle of 45 degrees reduces their ultra-violet outputs 30 and 40%, respectively. Eliminating the wire screen on the Type S-1 units increases their output about 20%.

* Also available for 28–32 volt circuits.

** Since the entire bulb glows this dimension is base contact point to center of bulb which is also the center of the electrodes.

† Estimated.

and gives a nearly perfect separation of color values in effective shades of gray.

In the field of motion picture projection, carbons have been developed which are steadier in burning and, in certain sizes, even higher in intrinsic brilliancy than those formerly obtained.

Precratering of high intensity positives has resulted in a more rapid burning in of natural craters and full intensity of illumination, as well as a resultant saving in costs by reducing the possibility of mirror or condenser pitting.

For searchlights used in airport floodlighting and military purposes, carbons have been developed which will give from 50 to 100 per cent more light at 225 and 250 amperes than has been possible previously with regular searchlight carbons.

Ultra-Violet—Incandescent Type

Last year's report mentioned the introduction of four new sources of ultra-violet radiation emitting little or no wavelength shorter than 2,800 and, therefore, safe for use in the home, the school, office, et cetera; *i. e.*, the Types S-1 and S-2 lamps, the Type G-1 or glow lamp and the CX lamps.

Considerable improvement has been made in these sources since their introduction. The essential technical data pertaining to them are given in Table I.

During the year very complete lines of fixtures have been placed on the market for the Types S-1 and S-2 lamps. Suspension and ceiling type units have been developed which have a spread of both the ultra-violet radiation and the visible light flux. Such units are finding wide application in places where the exposure periods are somewhat limited, such as in swimming pools, gymnasiums, hospital solariums, lunch and recreation rooms, et cetera.

For use in offices, schools, et cetera, where it is desired to combine the health maintenance value of ultra-violet radiation with the lighting over exposure periods of 6 to 10 hours, a third line of equipment, known as dual-purpose lighting fixtures, has been developed. Most of these utilize regular incandescent lamps for indirect or semi-indirect lighting and also an ultra-violet lamp and reflector so designed as to spread a mild intensity of ultra-violet over a wide area.

Gaseous Tube Electric Illuminants

It has long been felt that possibilities of materially higher efficiency of light production lie in the domain of electrical discharge through gases rather than in incandescence. While incandescent lamps, with which most artificial lighting is accomplished, are serving the purpose exceedingly well, despite limitations of theoretical low efficiency of light production, and are undergoing gradual evolution which appears to bring them closer and closer to the limits of the possibilities of production of light by incandescence, the engineering world is favorably predisposed toward the idea of achieving efficiencies of a higher order from gaseous tube illuminants.

The present low-voltage gaseous and mercury-vapor arc tubes make available to the illuminating engineer additional lighting tools having characteristics that possess value for particular purposes. Thus the mercury arc lamp, with its characteristic green-blue light, provides a "work light" which has peculiar value for certain industrial applications. The arc tubes of neon or other gases, with their characteristic instantaneous response to electrical discharge, are especially useful in television, stroboscopic work, et cetera. Further, the vivid colors of these tube illuminants make them applicable for certain special uses, such as aircraft beacons, and for publicity purposes. These sources, however, are of the same order of efficiency as tungsten filament lamps.

Beyond these developments the committee has information only of experimental developments in low voltage gaseous arc tube sources. Among these the highest efficiencies of light production attained are in tubes of high power. Pirani's oft-cited sodium tube of special sodium-resistant glass, heated independently to 350 deg. cent. and enclosed within an outer evacuated tube, is said to attain 70 lumens per watt applied to the tube itself. It produces light of a brilliant yellow color. No data are available as to the power required for the complete equipment. Neon and mercury-vapor low-voltage arc tubes, three or more feet in length and consuming 1,000 to 2,000 watts, are said to attain to 35 to 50 lumens per watt. In smaller sizes of lower power input very much lower efficiencies of light production are attained.

In the opinion of the committee attempts to develop gaseous arc tube light sources of a materially higher efficiency than modern incandescent lamps are interesting and perhaps promising. Of practical achievement in the way of commercially applicable illuminants the committee has nothing new to report at this time.

Application of Light

New and Improved Incandescent Lamp Equipment

The standard dome reflector and the glassteel diffuser remain as standard lighting equipment for industrial areas. Recent developments have improved the methods of hanging these reflectors so as to reduce the time required and the cost of cleaning and relamping. The high intensities of light required on certain working areas can be secured by the use of recently developed industrial projectors which can be mounted on the ceiling, side walls or columns and adjusted to project the light in any desired direction.

A totally enclosed semi-indirect lighting unit has been developed with the bottom of the bowl of high density glass and the top portion practically clear. This type of glass makes a highly efficient unit and one easily maintained.

Appearance of the lighting equipment is playing a very important part in commercial installations. The contours of enclosing globe units are more pleasing in design and hangers are receiving considerable attention from the design standpoint. An interesting development in the indirect type of unit is

one constructed entirely of metal louvers which can be obtained in a variety of color finishes.

Outdoor lighting such as the floodlighting of buildings and areas devoted to outdoor sports is increasing in popularity. This is partly due to the development of more efficient floodlight projectors and the introduction of open type floodlights. Many manufacturers have discarded the plain parabolic mirror for compound curves forming 2 and 3 surface mirrors. This increases the efficiency and permits accurate control of the beam.

The floodlighting of homes for holiday decorations, and gardens during the summertime, is now made possible by the development of small floodlight projectors designed for use with 100- and 150- watt lamps.

Street Lighting

Street lighting has been referred to frequently, by engineers, as the application of electric light where the practise has lagged most behind growing needs. During the year the demand for smaller municipal expenditures has been reflected in numerous proposals for reduced street lighting. Considerable apprehension was felt by experts lest serious increases in traffic and crime hazards should be incurred for only negligible savings. So far no extensive reduction has been made and several cities, where reduced lighting was tried, returned promptly to former illumination. On the other hand there has been a definite arrest in the advance of street lighting.

Group Replacement of Lamps

Since incandescent lamps operate with almost no attention and a substantial proportion of them last beyond their economic efficiency, many installations fall below their proper illumination performance. The obvious cure is systematic cleaning and replacement at suitable intervals. A recent awakening to the importance of such practises is showing good results. Already about thirty utility companies are applying "group replacement" to their street lighting. Noticeable improvement in illumination and reduced outages are being secured at little, if any, increased expense. Similar methods are applicable to traffic signals, large buildings, large signs, and wherever lamps are grouped in sufficient numbers to permit economic organization of maintenance.

In connection with group replacement, it is desirable to segregate used lamps which have considerable life expectancy from those which are approaching failure. This is facilitated for clear bulb lamps by a new inspection box, which reveals filament defects.

Railway Signals in Locomotive Cabs

Many serious accidents on railroads have resulted from failure of the engine crew to see signals. A new system, being applied extensively by a leading railroad, has a light signal in a conspicuous position in the locomotive cab, where it is independent of weather conditions and its view not limited to a fleeting glance. A sound device calls special attention to changes. The enhancement of safety is obvious.

Sports Lighting

The increasing popularity of artificial illumination in this field is due to the use of more adequate levels of lighting. For example, in football fields about 15 foot-candles have been found to be desirable in contrast to the 5 to 7 foot-candles often recommended in the past. For baseball fields a consumption of about 300 kw. is considered necessary now, whereas 200 kw. was about the maximum of former attempts.

Lighting of Buildings Exteriors

The application of artificial light to the exterior of buildings is making rapid progress, especially in the endeavor to create artistic night-time effects. Lighting effects formerly obtaining only by floodlighting are, in some of the newer buildings, being improved upon by novel methods. Today architects are designing buildings with the idea of artistically lighting the exteriors at night. They are paying attention to the direction of light projection and so designing as to create night-time as well as day-time effects on their buildings. One development is the use of luminous panels built into the façade of the building. Pilasters of diffusing glass behind which are mounted various colored lamps connected to dimmers produce changing color effects. Entire façades are covered with panels of this sort or constructed of glass brick which can be illuminated from behind at night. The development is following gradually that of built-in lighting for interior use.

Built-In Lighting

It is illogical to wait until a building is completed before considering lighting equipment, yet in the past this was generally the case. Now, fortunately, in most new structures the artificial lighting is designed as a component part of the interior. Manufacturers of diffusing material, such as glass, molded plaques and translucent substances, have made available many new varieties and these are finding application. Conventional fixtures designed on traditional lines are passing rapidly from the picture.

Residential Lighting

While the number of newly electrified homes in 1931 decreased to one-seventh the number added in 1930 and to one-seventeenth the number added in 1929, the consumption of electrical energy in homes showed an increase of approximately 8 per cent in 1931, only three or four points less than the increase in previous years when new residential building was at high levels. Decreasing hours spent in the various places of entertainment outside of the home have

meant increasing evening hours at home for all members of the family, calling for a greater use of electric light.

The portable lamp has grown in popularity as is evidenced by the increasing number of styles and designs which have been produced. The indirect portable lamp using a 200- or 300-watt lamp has not usurped this field although it has continued to grow in numbers. Decorative floor and table lamps using the Type S-2 lamp have made their initial appearance.

Lighting fixtures providing indirect or semi-indirect lighting and selling at very low prices have been received favorably in various parts of the country for the relighting of certain rooms of the homes of "minimum bill" customers. The design of these fixtures is such that they may be fastened directly to existing single sockets.

The President's Conference on Home Building and Home Ownership devoted a section of its Fundamental Equipment Report to the Wiring and Lighting of the Home, giving attention to these home modernizers equal to that devoted to such items as heating, ventilating, and plumbing.

Automobile Lighting

By means of a three-filament headlamp, a lighting system has been developed giving an asymmetrical distribution of light with reference to the car axis in which more light is directed to the right side of the road, particularly when passing another car. This system is so arranged that a city-driving and a country-driving range of light control is provided.

The advantages of directing more light to the right when passing are well recognized and several auxiliary lighting units are available which when used in connection with the present standard dual beam system provide this desirable passing light.

On some cars the fender lights serve a dual purpose, the switch control being so arranged that in addition to acting as marker lights when the car is parked these fender lamps are lighted when the beam is depressed, thus showing the oncoming driver that the depressed beam is being used and giving in addition an indication of the extreme width of the car.

Two rear lamps are being supplied for many current model motor cars. These lamps are generally a combination rear and signal unit. The majority of rear units are equipped with reflex glass which gives an indication from the reflected light thrown on it. The use of reflex materials in conjunction with incandescent lamps is considered desirable from a safety standpoint. Incandescent lamps are being used also to indicate when the engine needs oil and whether or not the battery is being charged.

Present day headlamp equipment, which is mostly of the fixed focus type, is capable of furnishing good road illumination with a minimum of glare but in order to obtain the maximum advantage from this equipment additional educational work is still needed which should be directed along the lines of encouraging car drivers to use the lower or depressed beam when meeting or signaled by oncoming cars.

Daylight vs. Artificial Light

Recently developed lighting equipment provides artificial light with supplementary ultra-violet radiation, exceeding that received from daylight filtered through window glass. This, coupled with improved electrical air conditioning, is rendering building construction independent of natural illumination. In a number of buildings recently completed or under construction, daylight has been purposely excluded.

Architectural Relations

Each year architects show a growing interest in the decorative as well as utilitarian possibilities of modern lighting. The Illuminating Engineering Society, in cooperation with the Beaux-Arts Institute of Design, has established an Illuminating Engineering Society Prize for which architectural students throughout the country compete. This year's project is designing the lighting for an exhibition hall at a world's fair. It is planned to continue this prize competition for the next decade.

The American Institute of Architects is cooperating with the Illuminating Engineering Society in the revision of the American Standard Code of School Lighting.

Light Control

The photoelectric light control relay is a device which regulates automatically the turning on and off of artificial lighting as the intensity of daylight decreases or increases. During the year such control was applied to the lighting of a school room where children in a special "sight-saving" class receive their instruction. Tests conducted in this room indicated that in order to maintain an intensity of 15 foot-candles, it is necessary to use the artificial lights at least 30 per cent of the time the room is in use.

Thyratron control of lighting is being applied to theaters, floodlighting of buildings, show windows, and electric fountains.

Thermionic tubes appear especially applicable for automatic dimming controls, where the only moving part can be small potentiometers or phase shifters actuated by very small motors. Applications of mobile color lighting with these controls include a floodlighted building, dance halls, night clubs, restaurants, and a number of theaters.

One of the most recent developments utilizes a continuous belt for controlling the potentiometer adjustment by providing a conducting path for each color or group of lights to be controlled. Any desired combination can be secured by varying the position of the conducting paths on the belt, so that any predetermined lighting effect can be repeated at will, or a new combination can be secured by "changing the roll." It is reported that the first installation of this arrangement will be to control the lighting of Buckingham Fountain in Chicago.

With the new thermionic tube controls the manual switchboard for theater and stage lighting can be very small, located in the orchestra pit, on the stage, or

even in the front rows of the orchestra. Now the "lighting conductor" becomes a reality and the lighting of the show is played by the conductor who sees and hears the entire action.

Illuminometer

A new portable illuminometer employing the photoelectric principle has become available. The photonic cell consists of a disk on which has been deposited light-sensitive material so that, when exposed to light, a slight but apparently constant electrical potential is generated. The readings are made on a microammeter connected to the cell by means of a flexible conductor cord.

For increased deflections two or more cells are sometimes mounted in a single housing and connected in multiple. Measurements and checks under incandescent lighting of the range ordinarily found indoors seem to show comparatively close agreement with the usual types of visual illuminometers.

Lighting Plans for 1933 Chicago Fair

A wide interest and curiosity has been exhibited by the public regarding the illumination of the 1933 Fair. It is not appreciated generally that the interiors of the Fair buildings will have no natural light. They will be illuminated both day and night by electricity. In general there are no windows or other openings through which natural light may enter.

One novelty will be shimmering effects on exterior walls such as is produced by reflection of the sun's rays from bodies of water in the daytime. A lighting projector built upon this principle will be used to throw fantastic moving color patterns on building walls. By agitation of the water in different ways, patterns of various forms may be produced. So-called scintillators will be used also. In this case squares of polished metal trembling on delicate supports will flash dancing color patterns over large areas of frosted glass. This is one of the few lighting effects that can be utilized in the daytime. The rays of the sun are allowed to penetrate the glass at many points and are reflected back by the metal squares in lively fashion, somewhat similar to the heliograph used by the Army for signal purposes.

Fluorescence will be used also. Many objects such as flowers, foliage, statuary, et cetera, will be treated with fluorescent materials and under so-called invisible light will appear in contrast with the surrounding foliage.

The possibility of fluorescent fountains has not been overlooked. There are several organic substances that may be added to water to produce fluorescence, such as eosine, fluorescene, and aesculin. Very small quantities of these substances added to water in a circulating fountain are sufficient to impart a mysterious glow to the water under so-called invisible light.

During the last few months the Fair has been experimenting with a great so-called flaming ladder arc, using a potential of 33,000 volts. Rising from a huge outdoor transformer will be two electrodes about thirty feet high. A flaming arc will start from the bottom of these electrodes and travel upward. As this intense flame dissipates at the top, another automatically starts at the bottom, so that there is a succession of fiery bridges or rungs in constant motion. Hence the term "ladder arc." As these arcs travel upward, dry chemical salts are injected by compressed air. These salts impart changing colors to the arc stream.

International Commission on Illumination

The International Commission on Illumination met in Cambridge, England, the week of September 13, 1931. In connection with the meeting a Congress was held in which meetings assembled in London, Glasgow, Edinburgh, Sheffield, Buxton, and Birmingham. Many notable demonstrations of illumination were made for these events and the subsequent celebration of the Faraday Centenary, among which were the lighting of the public buildings and streets of London and Edinburgh Castle. Excellent progress was made toward international understanding on illumination problems.

A new topic was Aviation Lighting in which international unity is especially important.

General

Revised Nomenclature and Standards

During 1931 there has been widely circulated for discussion and criticism a revised set of terms and definitions to supersede the American Standard "Illuminating Engineering Nomenclature and Photometric Standards" issued in 1925. The changes which have resulted from this discussion are largely matters of form rather than of substance. The new edition of the nomenclature will show, therefore, few radical departures from the established practise, but is believed to be somewhat more clear and logical.

Primary Standards of Light

International discussion of fundamental photometric problems has continued and several laboratories abroad are reported to have in progress experimental tests of the form of primary standard proposed by the Bureau of Standards. This standard consists of a refractory tube immersed in molten platinum at its freezing temperature. The tube is so constructed and observed as to be a "complete radiator" or "black body." Its brightness as found at the Bureau of Standards is 58.85 candles per square centimeter. The question of accepting this standard is before the International Commission on Illumination and the International Committee of Weights and Measures, but a decision must await independent

confirmation of the Bureau's results by some other national laboratories.

Death of Thomas A. Edison

The Committee on Production and Application of Light cannot conclude its report without allusion to the passing of the founder of the electric lighting industry. His death on October 18, 1931, was the signal for an expression of worldwide appreciation of the services and of the life of the man whom electrical engineers have held in high regard by reason of his inauguration of electric light and power as a widespread service to the public. Edison passes but his work goes on. He lives in the esteem of those who carry on under the banner which he raised.

Applications to Mining Work

ANNUAL REPORT OF THE COMMITTEE ON APPLICATIONS TO MINE WORK*

THE past year has been one of very greatly reduced activity in all classes of mines. New machines and new applications of electricity in mining work have been few and, generally, of a minor nature. There has, of course, been no incentive to force production or to increase the capacity of mines, and labor-saving devices have not been in demand because of an unwillingness on the part of operators to aggravate the bad unemployment situation. However, there have been some installations and devices worthy of comment.

A West Virginia coal mine has installed a passenger elevator to expedite the movement of men in and out of the mine and to relieve the production hoist of this service so that it can continue in its regular duty. This elevator has all of the safety and control features of a high-speed traction-drive office elevator. It handles twenty men per trip in a shaft 347 feet deep at a speed of 450 feet per minute. As this elevator travels in the intake air compartment, the car has certain special structural features to permit an uninterrupted flow of air.

Some companies have found it profitable to operate their mines only at night to secure a lower rate for electric power at the off-peak period. Power economies have also been effected by the use of power demand limiters. An installation of capacitors for power factor correction has shown a return of approximately 7 per cent per month.

Two new electric cap lamps for use in gaseous mines have been developed. One of these, weighing only 63 ounces, gives a beam candlepower of 26 at the beginning of a shift and the other, which weighs only 87 ounces, gives a beam candlepower of 55 at the beginning of the shift. A flood lamp, particularly designed for lighting the face for cutting and loading, gives a beam candlepower of approximately 350. All of these lamps have been approved by the U. S. Bureau of Mines.

Improved performance is being regularly obtained from cutting and loading machines. One operator reports that a cutting machine regularly cuts 1,000 to 1,200 tons in 6 to 7 foot coal in a shift, and that he is regularly obtaining 375 tons per day from his loading machine.

A Western Pennsylvania mine has installed a system of automatic door control, using "the electric eye" as the controlling relay. The mine doors are caused to open and close in proper sequence for either direction of movement of the trip.

A wound-rotor induction motor with direct-current excitation of the primary has been installed as a braking generator to replace mechanical brakes, holding a rope haul trip at proper speed down grade. The high expense of brake maintenance has been practically eliminated.

Several large induction motors and synchronous motors with automatic line-start control have been installed for pumping in the anthracite field. The controls for several of these are housed in cubicles and completely erected at the factory.

A large, high-speed, heavy-duty, variable-voltage hoist, taking its power from a synchronous motor-generator set, has been installed in Canada. The rotating equipment consists of a 1,250-kw. generator, an 1,800-hp., 750-r.p.m. synchronous motor and a 1,550-hp., 68-r.p.m. hoist motor. The skip has a capacity of 6 tons of rock per trip and travels at a speed of 2,200 feet per minute.

A new light-weight self-propelled cutting machine has shown favorable results over several months of trial. The machine has a very high-speed cutter which resembles in its operation a band saw more than the usual type of cutter.

The construction of new coal-cleaning equipment kept pace with progress of previous years in this line. It is estimated that 8,000 tons per hour of complete mechanical cleaning capacity were installed in 1931 in addition to 20,000 tons of capacity for cleaning and sizing. All of these tipples and cleaning plants were, of course, electrically driven.

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* COMMITTEE ON APPLICATIONS TO MINING WORK:

D. R. Renshaw, Chairman,
A. R. Anderson,
Graham Bright,
J. H. Edwards,
E. J. Gealy,
L. C. Ilsley,
L. H. James,
J. E. Kearns,
Carl Lee,
W. H. Lesser,
C. W. Parkhurst,
F. L. Stone,
J. F. Wiggert,
C. D. Woodward.

Transmission and Distribution

ANNUAL REPORT OF COMMITTEE ON POWER TRANSMISSION AND DISTRIBUTION*

THE activities of the Committee on Power Transmission and Distribution have continued through the past year along the lines organized in previous years. Various subjects of interest to the Institute membership have been treated in a number of papers presented before the conventions and district meetings.

A brief outline of the activities of the several subcommittees follows:

Subcommittee on Steel Transmission Towers and Conductors

Subjects relating to steel towers have been studied and certain items of general interest are now being given particular attention preliminary to the preparation of future reports.

A report has been drafted outlining the requirements for modern steel tower transmission lines which, after review, it is expected will be published. Conductor vibration has been given intensive study. A direct result of this work has been the publishing of a bibliography including all available data on the subject of vibration. A session at the Summer Convention is devoted to this important subject.

Subcommittee on Distribution

Continued consideration has been given to the various broader aspects of distribution, including developments in secondary and primary networks.

Of particular interest to distribution engineers is the symposium presented at the Winter Convention consisting of six papers on distribution circuit lightning protection. This symposium summarized the results of intensive field and laboratory experimental work and analyses of operating experience. It is believed that this material will be productive of improvement in distribution equipment and construction practises and in service reliability.

Subcommittee on Cable Developments

There have been no marked innovations in the cable art during the past year, although study has been continued on the developments indicated in previous reports. In the high voltage transmission cable field, the highest voltage submarine cable crossing in the world, across the Columbia River near Portland, Oregon, is also the first of the oil-filled type used in submarine work. The cables are 750,000-cir. mil., single-conductor, rated at 115 kv., and an insulation thickness of 0.550 inch. An unusual feature is the use of hard-drawn-copper armor wires, instead of the usual steel, in order to reduce the losses in the armor and thereby increase the rating to 114,000 kva.; over 30 per cent more than if steel armor had been utilized.

The performance of experimental installations of 132-kv. cables, one of the oil-filled type with reduced insulation and the other of the solid type, in Chicago and in Newark, respectively, has continued to be successful.

Subcommittee on Interconnection and Stability

The joint subcommittee on interconnection is formed from representatives of the Power Generation, Protective Devices and Power Transmission and Distribution committees. During the year the scope of the committee was increased and representatives were added from the Committee on Electrical Machinery.

This joint subcommittee sponsored a session at the Winter Convention on the subject of Decrement Curves and Power System Stability. Two other stability papers were presented during the year.

Subcommittee on Lightning and Insulators

The necessity for establishing a definite wave or group of waves by which to measure impulse strength of insulators has been recognized for some time. In the interest of greater uniformity in test practises, agreement has been reached on a tentative group of waves (1) which would closely approximate the effects of natural lightning voltages imposed on apparatus connected to transmission systems; (2) which could be produced with available laboratory equipment; and (3) on which considerable impulse data have already been secured by various laboratories which have been investigating the performance of insulation under impulse voltages. The following three waves have been agreed upon as preferred test waves for impulse testing. These waves are designated as $\frac{1}{2}$ x 5, 1 x 10, and $1\frac{1}{2}$ x 40. The first number indicates the microsecond time to crest, and the second number the time in microseconds from zero to 50 per cent of crest on the tail.

Another development in the lightning field has been continued this year in the factory test of commercial transformers with artificial impulse waves. It appears that the manufacturers are now in a position to test commercial transformers in the higher voltage ranges with artificial impulse waves, and a recommendation has been made that a committee formulate the procedure to be followed in applying

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* COMMITTEE ON POWER TRANSMISSION AND DISTRIBUTION:

P. H. Chase, Chairman,
L. N. Conwell, Vice-Chairman,
T. A. Worcester, Secretary,

Sydney Ailing,	Edwin Hansson,	A. E. Silver,
F. E. Andrews,	K. A. Hawley,	D. M. Simmons,
A. B. Campbell,	L. F. Hickernell,	C. T. Sinclair,
C. V. Christie,	D. C. Jackson, Jr.,	L. G. Smith,
A. E. Davison,	J. P. Jollyman,	H. H. Spencer,
H. C. Dean,	A. H. Lawton,	Philip Sporn,
L. L. Elden,	I. E. Moultrop,	W. K. Vanderpoel,
R. D. Evans,	L. L. Perry,	C. F. Wagner,
F. M. Farmer,	T. F. Peterson,	H. S. Warren,
T. H. Haines,	D. W. Roper,	

impulse waves to transformers. This work is already in progress.

Field investigation of natural lightning which has been in progress for the last few years has been continued on a decreased scale.

Discrepancies in 60-cycle flashover values of insulators mentioned in last year's report as due to humidity conditions have been further studied this year. Papers fully covering this subject have been presented before the Institute during the year.

Reference has been made above to the field, laboratory, and operating investigations relating particularly to 2,300- and 4,000-volt distribution lightning protection. Of particular interest is the apparent benefit to be derived from interconnecting the primary arrester ground with the secondary neutral, if the latter is well grounded.

Conclusions

In conclusion, the committee wishes to express its gratification at the interest evidenced in the field of Power Transmission and Distribution by the papers submitted and by the attendance and discussion when presented.

This interest together with that displayed by the members of the committee, and by those associated in the work of its subcommittees, have made possible the accomplishments of the committee.

Power Generation

ANNUAL REPORT OF THE COMMITTEE ON POWER GENERATION*

ALTHOUGH the past year has recorded no major strides in power plant design and construction not heretofore discussed in committee reports, the committee has been successful in obtaining a variety of papers of a critical nature for Institute presentation, surveying present practise, with the object of indicating probable lines of advance when the construction of new or additional power projects again becomes active. Following the custom of preparing progress reports only at biennial intervals, the committee report for the past year will merely recount briefly the results accomplished by the several subcommittees engaged in planning and securing technical papers.

The Joint Interconnection Subcommittee, of which F. C. Hanker served as chairman, was instrumental in presenting at the Winter Convention six papers embracing several phases of the subject of stability of power systems, including that of *Stability of Conowingo Hydroelectric System*, by R. A. Hentz and J. W. Jones. A record of the most recent technical advances in power system design and operation was given in that paper. Another valuable paper concerned the standardization of nomenclature regarding stability, being a report by H. K. Sels.

Another session at the Winter Convention was sponsored by the subcommittee on Power Station Auxiliaries, composed of H. W. Leitch and F. H. Hollister. The comparative merits of steam and electric drives for steam power stations were analyzed in papers by W. Poole Dryer and L. W. Smith, advocating opposing views, and in a summary statement by F. H. Hollister.

A subcommittee headed by N. E. Funk has arranged a symposium of four papers on *Combined Economy and Reliability in Operation of Large Electric Systems*, for the Summer Convention. Current practise in the Boston, Chicago, Detroit, and Philadelphia areas will be discussed at that time.

Other work consisted of a review by I. E. Moultrop and J. B. Crane of the economics of the design and use of high-temperature and high-pressure steam equipment, with a supplementary discussion of the use of welding in modern fabrication methods. A paper on this subject awaits opportunity for presentation. The subcommittee on Hydroelectric Practise, J. P. Hogan, chairman, will offer a paper by A. V. Karpov on *Low-Head Hydroelectric Developments* at a Fall District Meeting featuring other papers on hydroelectric subjects. F. A. Annett of the subcommittee on the Design of New Plants has reviewed papers describing the Waukegan and Ashtabula plants, and has cooperated in having the subject of power generation adequately represented on the program of the Pacific Coast Convention this summer.

The Committee recommends that the recent innovations in the design and application of switching structures at power plants be given major attention during the coming year. For that purpose a subcommittee, A. E. Silver, chairman, was appointed which has been assembling data and information for a discussion of that topic next winter.

The Committee wishes to take this opportunity to record its thanks for the assistance given by the several authors and the many discussers of papers to the end that the progress in the field of Power Generation be adequately reported by the committee.

* COMMITTEE ON POWER GENERATION:

J. R. Baker, Chairman,
F. A. Allner, W. S. Gorsuch, E. B. Meyer,
F. A. Annett, F. C. Hanker, I. E. Moultrop,
D. S. Brown, L. F. Harza, F. A. Scheffler,
Andrew Carnegie, J. P. Hogan, F. O. Schnure,
J. B. Crane, F. H. Hollister, R. E. B. Sharpe,
E. A. Crellin, A. H. Hull, A. E. Silver,
R. D. DeWolf, H. W. Leitch, A. R. Smith,
W. P. Dryer, A. H. Lovell, E. C. Stone.
N. E. Funk,

General Power Applications

ANNUAL REPORT OF COMMITTEE ON GENERAL POWER APPLICATIONS*

DURING the past year the committee has not sponsored a session at any of the meetings or conventions, but has reviewed and reported upon a number of industrial papers. Two of these papers were presented at the Pacific Coast convention at Lake Tahoe, August 1931, and as far as we know these were the only industrial papers presented at district meetings before the Institute during the year. These two papers are as follows:

Electrical Equipment for Oil Field Operations, by H. C. Hill and J. B. SeLegue

Electric Power in the Wood Products Industry, by C. E. Carey and K. L. Howe

Although the general activity of practically all industrial plants and machinery manufacturers has been greatly curtailed during the year, nevertheless, this extremely competitive situation is responsible to some extent for a number of developments and improvements in industrial equipment which have been brought out. Last year we mentioned the interest that was being shown in connection with the use of electronic tubes for industrial applications. The various characteristics which these tubes possess which are not otherwise obtainable are almost daily finding new industrial uses. A large number of these applications falls under the classification of process control and are in line with the trend of the times toward elimination of waste, reduction of cost, and more accurate control of all manufacturing processes. Most of these electronic developments are given publicity in the various trade papers or in *Electronics* and to keep posted on such activities constant contact with such literature is necessary. A comprehensive review in a report of this kind is entirely impossible.

During the year considerable attention has been given by various electrical machinery manufacturers to the design and construction of motors, controllers, safety switches, push-buttons, and other details to meet the requirements for Class II Hazardous Locations as defined by the Underwriters' Laboratory. Such equipment, although required for such locations in flour mills, grain elevators, starch plants, coal pulverizing plants etc., finds numerous other desirable applications where its installation results in lower maintenance cost and improved operating conditions.

Instead of attempting to abstract information regarding the numerous developments in industrial apparatus or application, the committee feels that members interested in such equipment can readily obtain such information directly and more completely from the various periodicals as, for instance, *The Electrical World*, *Maintenance Engineering*, *G. E. Review* or *Electric Journal*, together with the various specific industry magazines. The January issue of such magazines generally contains a review of the year's achievements in a much more complete and interesting form than could be given in a report of this kind.

* COMMITTEE ON GENERAL POWER APPLICATIONS:

C. W. Drake, Chairman,
A. H. Albrecht, Fraser Jeffrey, A. M. Perry,
E. A. Armstrong, A. M. MacCutcheon, D. M. Petty,
James Clark, Jr., H. A. Maxfield, H. W. Rogers,
J. F. Gaskill, John Morse, L. D. Rowell,
John Grotzinger, N. L. Mortensen, W. K. Vanderpoel,
Truman Hibbard, M. R. Woodward.

Iron and Steel Production

ANNUAL REPORT OF COMMITTEE ON APPLICATIONS TO IRON AND STEEL PRODUCTION*

General

IT is estimated that the steel industry expended approximately 35 million dollars in 1931 for the purchase and installation of new apparatus, the maintenance of old equipment, and in the purchase or generation of electric power.

During the year there were purchased 63 main-drive motors of more than 300 rated hp. each. The total rated horsepower of these drives aggregated 119,325 hp. These figures compare with the installation of 163,490 hp. which occurred in the year 1930.

A major trend toward increased use of refined control equipment for automatically performing tasks which had previously required manual labor was continued during this year. While such equipment was installed at a reduced rate in 1931, the percentage of men whose duties were no longer required in the steel industry due to such automatic devices increased.

* COMMITTEE ON APPLICATIONS TO IRON AND STEEL PRODUCTION:

A. C. Cummins, Chairman,
F. B. Crosby, A. M. MacCutcheon, G. E. Stoltz,
Wray Dudley, F. O. Schnure, T. S. Towle,
J. E. Fries, W. B. Shirk, H. A. Winne.
S. L. Henderson,

Main and Auxiliary Drives

The 44-inch universal slabbing mill in the Chicago District, referred to in last year's report as being under construction, was completed during the early part of 1931. The upper and lower main horizontal rolls are driven by two 5,000-hp., 40/80-r.p.m., 700-volt, double-armature reversing motors, and the auxiliary vertical rolls are driven by a 2,500-hp., 79/225-r.p.m., 700-volt, single-armature reversing motor. The total continuous capacity of the three motors is 12,500 hp., and the maximum emergency capacity about 35,000 hp., nearly a third greater than any similar mill. The three motors are connected in parallel and are supplied with variable-voltage direct-current power from a 10,500-kw., 5-unit, six-bearing flywheel motor-generator set, consisting of three 3,500-kw., 700-volt generators, a 6,500-hp., three-phase, 25-cycle, 6,600-volt, 370-r.p.m. wound-rotor induction motor and a 180,000-lb. flywheel. When running at synchronous speed, the total stored energy in the rotating parts of the motor-generator set is approximately 270,000 hp-seconds. Latest operating data indicate this installation has proved quite successful.

A recent installation of induction motors and control for operating "catcher tables" has fulfilled the expectations of not only the operators, but of the mill designers and electrical manufacturers as well. These tables are used in the rolling of sheet steel and take the place of the older manual methods of handling the sheets and packs during the rolling process. The cycle of operations includes carrying the material into the mill by means of the roller table, receiving it on the catcher table, tilting the tables upward, transferring the sheet over the top roll back to the roller table, returning the tables to the down position, and reversing the direction of travel back into the mill. This cycle of operation must be completed under some circumstances in three seconds, which means that the motors must be capable of reversing or starting at the rate of 40 times per minute.

Special low-inertia, low-speed motors have been developed to cover this type of application. The speeds used are 375 r.p.m. for 25-cycle supply and 450-r. p. m. for 60-cycle supply. The use of squirrel-cage motors for such duties as this has been attempted only within the past two years, but it is an indication of the changing trend toward the application of simplified motor and control apparatus. Formerly, direct-current mill-type motors were thought the only solution for such problems.

During 1931, the first American installation for producing seamless steel tubes by the "push bench method" was completed. In the production of seamless steel tubing by this method, a heated blank is placed in a hydraulic press and formed into the shape of a thick walled thimble. The thimble is then placed on the end of a mandrel and forced through a series of stationary ring dies, which gradually decreases the wall thickness, and at the same time elongates the thimble, thus forming a long tube with a closed end. After the elongated thimble has been forced by the mandrel through the various dies, the mandrel is withdrawn and the closed end of the tube sawed off. Sizing and finishing is carried on subsequently in mills of the usual design. The power required on this application is approximately the same as that used by the piercing process.

In the installation just completed, the mandrel is forced forward through the dies by means of a rack and pinion which is driven by a 1,500-hp. variable-speed d-c. reversing motor. The control for this equipment is so arranged that upon indications from the operator, the motor will start, accelerate the ram, force the material through the dies at a predetermined rate of speed, then stop, reverse, and return the mandrel to the initial position. Means are provided for adjusting the speed of the stroke over a wide range, and extremely fast acceleration and retardation are necessary to meet the operating cycle. Devices are arranged in connection with this control to prevent the ram from overrunning in either direction. The manufacture of tubes by this process is expected to produce a small seamless tube at very low cost and for this reason it is probable that additional installations of similar equipment will follow.

Two steam engine drives in the Pittsburgh District were replaced by motor drives. A three-high roughing mill driven by a 1,500-hp. steam engine has been re-equipped with a 1,600-hp. wound-rotor induction motor. Likewise a reversing steam engine on a two-high finishing mill has been replaced by a 1,250-hp., d-c. reversing motor. This reversing equipment is said to be one of the smallest applications in the steel industry of reversing main roll drive equipment.

There have been two major hot strip mill installations made during the year. One of these consists of a 72-inch continuous hot strip mill and the other a 76-inch continuous hot strip mill. It is understood that both of these mills are equipped with anti-friction bearings on the main rolls throughout, and combine the use of induction motors on the preliminary stands, synchronous motors on the intermediate stands and d-c. adjustable-speed motors on the finishing stands. It is unusual to find the three types of main roll drive combined in one mill installation, but it was possible on these particular mills to secure the necessary relations between peripheral roll speeds without the use of expensive adjustable-speed d-c. drives throughout the entire mill.

The largest motor equipment ever sold for driving a cold strip mill was also installed during the year. Each of the two stands of this cold strip mill are driven by a 1,500-hp. adjustable-speed, d-c. motor. A tension reel driven by a 400-hp., adjustable-speed, d-c. motor, receives the material from the two cold roll stands. It is apparent that the year has witnessed a change in the electrical equipment used in the rolling of both hot and cold strip.

New designs of electric contactors were announced by one of the leading manufacturers during the year. Decided progress was made by a committee of steel mill engineers toward the standardization of control equipment. It is felt that it will be but a short time until a satisfactory steel mill control standard will be an accomplished fact.

Several new tension-limiting devices were designed

for automatic reeling applications. Some are designed to place a predetermined tension on reels coiling strips after they are rolled, while others are between stands of the finishing passes. Automatic screw-down equipment for two-high and universal mills of simplified design appeared. This apparatus uses electron tubes to replace cumbersome limit switches. However, no installations of this type of screw-down control have been completed at the time this is written. Automatic screw-down control assures uniformity in rolling practise, independent of the whim of the operators, and has resulted in a material improvement in the quality of the product of rolling mills where it has been in service. The apparatus used in the past has been quite complicated and it is felt that the new devices tending to simplify this type of equipment will prove to be a worth while development and result in more general use.

Synchronous Motor Control

The recent remarkable increase in the use of synchronous motors in steel mills has made their characteristics, operation, and control a subject of great interest to steel mill electrical engineers. The favorable status of the modern synchronous motor was not achieved, however, until definite limitations of the earlier designs were overcome. Modern design and construction have removed most of these earlier limitations until now the synchronous motor starting, pull-in, and pull-out torques are exceptionally favorable for applications heretofore reserved for induction and direct-current motors.

A recent development of unusual interest has taken place in control systems for synchronous motors. This development is the culmination of investigations started many years ago which have done much to extend the field of application of the synchronous type motor. Recent systems of control automatically start the motors under the best conditions, in the shortest time, and keep them running through nearly all power supply disturbances of a transient nature. In short, modern synchronous motor control eliminates many of the starting and operating difficulties, which prevented their extensive acceptance in industrial fields.

Modern synchronous motor-control systems comprise the following separate features:

1. Part winding starting, resulting in reduced starting kva.
2. Transfer to full voltage by means responsive to the electrical condition of the field winding.
3. Synchronizing by means responsive to the electrical condition of the field winding.
4. Delayed low-voltage release.
5. Field kick-off and resynchronizing (where the load permits).
6. Unloading and reapplication of load to driven machine.

Not all of these features are required for every application, but those are employed that accomplish best possible starting under all conditions and continuous operation through momentary power or load disturbances.

Electric Furnaces

Several installations of electric furnaces for bright annealing coiled steel strip were completed and placed in operation during the year. Each furnace consists of a bell type heating chamber and several bases or cars upon which the coiled strip is stacked. An inner hood or cover of heat-resisting alloy is placed over the stack and serves to exclude air both during the heating period and while the coils are being cooled. An atmosphere of illuminating gas or other suitable gas is maintained under the hoods to prevent oxidation.

A new type of furnace, applicable especially to annealing steel sheets, has been developed in which a load of material can be cooled in the furnace in a comparatively short time. With previous types, the cooling rate of a loaded furnace is so slow as to make furnace cooling impracticable. The new furnace is lined with light weight refractory brick so that the heat storage in the furnace walls is comparatively small. It employs a circulating system for the furnace atmosphere, with an external cooler by means of which the heat may be extracted and the furnace again charged at a more expeditious rate than was possible heretofore.

Material Handling

There has been installed in the Pittsburgh District a large ore bridge using a bucket of 17 tons capacity. The bridge span is approximately 190 ft. The outstanding feature of the bridge is the unusual use of compressed air for control. Ten motors, 275 to $7\frac{1}{2}$ hp., are controlled by electropneumatic type control, similar in design to standard railway equipment. This arrangement, it was found, required less space and lower maintenance. The brakes are spring set and air released for quick, positive stopping. Due to the large volume of air required, there are three sets of compressors and reservoirs, one in the operating cab and one in each leg of the bridge. The bridge in normal service can handle 1,000 tons an hour and serves several blast furnaces located nearby.

Electronic Devices in the Steel Industry

The past year has seen a rapid increase in the number, diversity, and ingenuity of applications of electronic devices in the iron and steel industry. These devices are now controlling shears, soaking pit covers, repeaters, and various mill table operations.

In one plant, a flying shear is located between the intermediate and finishing stands of a 10-inch hot strip mill. This shear is to cut off the relatively cool front end of the bar before it enters the finishing stands. Formerly an operator was necessary to trip the shear when the strip was in the proper position, so as to cut off a definite crop length. Now a photoelectric tube automatically trips the shear. An adjustable time-delay relay is used to determine the time interval between the interruption of the beam of

light and the starting of the shear, thus compensating for the changes in the strip speed.

In another plant, considerable trouble was encountered in maintaining a flag switch on a back blooming mill table, used to control the operation of a recording pyrometer. A photoelectric tube with the required amplifier unit and relays now performs the operation in a more reliable and accurate manner.

Several installations have been made which permit crane operators to control heating furnace doors by means of photoelectric equipment. A number of other steel mill applications of photoelectric devices have been made, such as skip-hoist limit stops, stock-bin level indicators, spotting of material in reheating furnaces, pyrometers, etc.

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All in all, 1931 has, in spite of adverse conditions, brought into being a number of new ideas and electrical developments in the iron and steel industry. Cooperative exchange of information has continued, and permitted the industry to benefit from individual as well as collective effort and development.

The Chairman wishes to express his appreciation for the assistance rendered by the members of the committee in the preparation of this report.

Bibliography

The committee submits a list of the principal papers that have been presented or published by various engineering societies covering more completely many of the subjects reviewed in this report.

1. "Twin Motor Drive," R. H. Wright and H. E. Stokes, *Iron and Steel Engineer*, June 1931, Page 246.
2. "Motor and Control Equipment," F. Mohler, *Iron and Steel Engineer*, June 1931, Page 272.
3. "The Hibbard Control System and Its Application to Synchronous Motors in Steel Mills," W. H. Feldman and S. P. Bordeau, *Iron and Steel Engineer*, December 1931, Page 483.
4. "Electrical Developments in 1931," *Iron and Steel Engineer*, January 1932, Page 7.
5. "Main Drive Statistics—1931," *Iron and Steel Engineer*, January 1932, Page 8.
6. "Electrical Developments in 1931," *General Electric Review*, January 1932, Page 30.
7. "Electrical Developments in 1931," *Electric Journal*, January 1932, Page 25.
8. "A Review of Electrical Developments in the Iron and Steel Industry," W. B. Shirk, *Iron and Steel Engineer*, February 1932, Page 107.
9. "The Application of Electron Tubes in the Steel Industry," D. W. Dean, *Iron and Steel Engineer*, March 1932, Page 124.
10. "Vacuum Tubes and Their Industrial Application," W. C. White, *Iron and Steel Engineer*, March 1932, Page 131.
11. "Electron Tubes in the Steel Industry," L. F. Worden, *Iron and Steel Engineer*, March 1932, Page 136.

Communication

ANNUAL REPORT OF COMMITTEE ON COMMUNICATION*

Committee Affairs

THE Committee on Communication continued the practise of outlining at the beginning of the Institute year tentative communication programs for each of the subsequent scheduled Institute meetings. In making up the year's outline, the Committee strove to select material which would be of broad interest to the Institute as a whole and, in particular, to foster the presentation of papers on subjects that had not been covered before or that had received but little recent attention. A successful endeavor was made to cover such subjects in a rather complete and thorough way. The advance planning of programs greatly aided this by allowing the Committee ample time to solicit authoritative papers discussing all the major aspects of each subject selected for extended treatment.

The more important groups of coordinated papers which in accordance with this general policy have been presented at Institute meetings during the past year are:

Symposium on Communication Services for Power Companies—1931 Summer Convention:

This was prepared with the cooperation of the Committee on Transmission and Distribution and is headed by a general review of the subject prepared by a joint subcommittee of the Committee on Communication and the Committee on Transmission and Distribution, followed by a group of individual papers prepared by power and communication engineers, discussing the solution of this problem in specific cases.

Symposium on Time and Time Services—1932 Winter Convention:

This is headed by two papers discussing the astronomical aspects of time and its measurement, followed by discussions of the time services given by the Naval Observatory, the telegraph companies, and the power companies. In arranging this symposium the Committee on Communication had the cooperation of the Committee on Transmission and Distribution.

Symposium on Traffic Control—Northeastern District Meeting, May 1932:

This is headed by a general discussion of traffic control followed by papers describing various electrical systems now having important fields of application.

Planning for Telephone Toll Service—Southwestern District Meeting, October 1931:

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C. H. Taylor,
H. M. Turner,
F. A. Wolff.

A group of three papers discussing, respectively, the forecasting of population, the general advance planning of telephone toll facilities, and certain technical problems involved in their design.

In addition, a number of individual papers has been presented under the auspices of the Committee at various national and regional meetings during the year, discussing important phases of new developments in the telephone, telegraph, and radio arts. The total number of communication papers, including the symposiums, presented at these meetings during the year was 33.

The communication sessions have been very well attended. The Communication Committee proposes to continue during the coming year its plan of developing programs involving groups of coordinated papers covering subjects of broad general interest.

Advance of the Art

In line with the aim to keep this report as short as practicable there are listed below only a few of the outstanding advances made in the field of communication last year.

During the year the Bell System introduced teletypewriter exchange service whereby any subscriber to this new service may secure a direct connection to any other subscriber over which the two may carry on instantaneously reproduced two-way typewritten communication with one another. The methods and switching equipment employed in establishing connections are similar to those employed in telephone practise.

Also during the year the Western Union Telegraph Company and the Postal Telegraph-Cable Company jointly inaugurated a new form of telegraph service known as "Timed Wire Service." This is available to customers who have simplex printers, and provides for the transmission of communications from any printer to any other at rates based on the time the facilities are in use, rather than on the number of words transmitted. Printer customers desiring this service will obtain connection at the central office with an automatic reperforator, which will directly prepare a perforated tape in form for retransmission to the city of destination without additional manual handling. At this point a second perforated tape will be automatically prepared and used for retransmitting the message to the customer addressed. The service is somewhat analogous to a one-way private wire connection, although a direct connection is not established. The Timed Wire Service routine permits of a more economical utilization of the trunk wire plant than would be possible were a direct connection of printers established.

An automatic concentrator was developed for use on printing telegraph circuits to provide faster and more economical service on customers' lines. The Postal Telegraph Company has installed several of these equipments.

A four-wire voice-frequency carrier telegraph system adapted to meet the requirements of a strictly telegraph plant was developed and an initial installation was made on the lines of the Postal Telegraph Company.

A new cable and radio operating center, serving jointly the Commercial Cable Company, the Mackay Cable and Telegraph Company, and All America Cables, was placed in operation last year. Circuits linking the United States with Europe, Central and South America, and the Far East terminate in this center and connect 85,000 miles of under-sea telegraph wires through 19 separate channels. Three cables to Central and South America and two New York-London cables have been equipped with recently developed printer apparatus which has greatly increased the accuracy of reception and has also effected substantial economies. A recently developed method for converting the non-uniform length signals of the Cable Morse Code into a modified 5-unit code, so as to permit of the operation of printers on long non-loaded submarine cables, is employed in connection with these printers.

A pneumatic tube carrier routing device has been developed by the Western Union Telegraph Company for automatically selecting and diverting tube carriers from a main tube into the proper branch tubes. Pneumatic tubes are used to carry telegrams between main and branch offices and between points in large main offices.

Recent achievements in cable making have included the standardization of cables of less than 1,800 pairs employing 26-gage wires, and the application of a new process of insulating small-gage conductors for exchange cables. Under the new method of insulating the cable wires, a coating of wood pulp is applied to each conductor from a bath of water-suspended pulp. This coating when it dries becomes a continuous uniform sleeve of porous paper surrounding the wire. Cables made from this material are of the same size and have practically the same operating characteristics as cables of the older type, for which wires are insulated by helical wrappings of thin, narrow manila paper ribbon. Four machines for producing pulp-insulated wire were placed in operation last year with an output capacity of about 200,000,000 feet of wire a week.

Bermuda, Hawaii, Rio de Janeiro, Java, Sumatra, and the Canary Islands were brought into telephone communication with the interconnected telephone system of North America by means of radio links established in the past year. The first three places are reached by direct radio circuits from the United States. Communication between the sending and receiving stations at Oahu, and the other islands of the Hawaiian archipelago, is secured by an ultra-high-frequency radiotelephone system put into service by the Mutual Telephone Company. This system is also used regularly in inter-island telephone service.

Single side-band transmission of short-wave radiotelephony was successfully demonstrated by the International Telephone and Telegraph Laboratories. The spread side-band system for use on short-wave radio telephone links has also been developed by means of which distortion effects due to selective fading can be largely eliminated. By an extension of the principles involved, a number of side bands can be placed on one carrier in such relative positions

to each other and the carrier that harmonic distortion as well as crosstalk between channels is eliminated.

A successful demonstration of two-way radiotelephony on an 18-cm. wavelength was given across the English Channel by the International Telephone and Telegraph Laboratories. This system, called "micro-ray," employs an antenna only 2 cm. in length. The greater directivity of these short waves makes it possible to employ the same wavelength for a number of separate channels closely spaced as to geographical separation, without mutual interference. Because of this, and the wide frequency band thus opened up, the commercial application of the "micro-ray" would make available nearly a quarter of a million additional radio channels.

Improvements have been made during the year in controllers for pre-timed traffic signals. One type is arranged so that signals may be automatically operated on different time cycles at different periods of the day or week. Another type is primarily intended to operate in connection with a flexible progressive system, but may be also used to meet the special requirements of detached street intersections. This provides for several functions in addition to the usual automatic stop-and-go control: manual control, flashing amber on one street and flashing red on the cross streets, lengthened green on the main street, pedestrian period, fire lane at one or more of the intersections and varying go periods at different intersections, while preserving the total cycle for progression.

Cleveland Repeats Its Invitation

To the Annual Summer Convention, June 20-24, 1932

The committees are working hard to assure you a profitable and entertaining visit. No registration fee.

Cleveland Museum of Art, inspection of which is included in the ladies' entertainment program for Monday, June 20, 1932

Canterbury Country Club, where play for the golf tournament will start on Monday, June 20. A new trophy has been provided by Past-President R. D. Mershon to take the place of the time-honored Mershon trophy which was permanently won last year, and a new trophy has been given by Past-President W. S. Lee. A large number of prizes, including four trophies for an A.I.E.E. District team competition, will be provided by the local sports committee.

Industrial Notes

Air Conditioning Department for G-E.—The organization of an air conditioning department within the General Electric Company, which will market various electrical devices for home heating, humidifying, and temperature control, has been effected, and one of the first products to be marketed by this new department will be a complete oil burning furnace. J. J. Donovan, of Cleveland, formerly in charge of apartment house refrigeration sales, will be manager. Associated with him will be E. D. Harrington, of Schenectady, in charge of application engineering; J. R. Rue, of Pittsfield, in charge of manufacturing, and H. S. Woodruff, of Schenectady, in charge of design engineering. Headquarters will be maintained at General Electric's New York offices, 120 Broadway.

American Steel & Wire Company Opens New Warehouse.—A new Chicago warehouse located at 2364 South Ashland Avenue is announced by the American Steel & Wire Company. The new depot supplants the Lake Street site and has the distinct advantage of a near south side location.

New Lifting Magnet.—The Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio, announces a new size, heavy duty lifting magnet known as the No. $3^1/_2$ type SA magnet. The new magnet is an intermediate size and intended for use with overhead, crawler, or other type cranes in foundries, scrapyards, etc. It requires a 5 kw., direct-current generator.

A New Dead-End Clamp.—The Ohio Brass Company, Mansfield, Ohio, has developed a new universal strain clamp to meet the need for a small, inexpensive dead-end clamp. It is designed especially for use in stringing distribution lines, substation buses, low current transmission lines, and overhead ground wires. Although of light weight, this new clamp will develop an ultimate of at least 10,000 pounds. High slip strength is provided by the "V" shaped seat and by the curvature of the clamp body. All conductors for which the clamp is designed are held securely in its grip. By means of a reversible keeper piece, A.C.S.R. or copper conductors from No. 6 to 4/0 may be accommodated. Clamps are supplied with or without a ball and socket eye. The clevis of the clamp may be connected directly to any of the other standard O-B clevis type suspension insulators and hardware.

Stibloy Now Produced by New Koppers Company.—The Stibloy Products Company, Inc., with principal offices in the Koppers Building, Pittsburgh, has taken over the assets of Liquid Metal Products, Inc., Chicago, producers and distributors, under the Arent patents, of Stibloy, a metal compound in liquid form, which acts as a primary coating to hold paint, enamel, and lacquer tenaciously, permitting immediate finishing of new galvanized metal surfaces. Stibloy was developed to extend the life of galvanized surfaces by protecting them from the effects of atmospheric conditions and from the damage caused by exposure to gases, acid fumes, smoke, and brine. It is used for protecting galvanized roofing, fences, screens, transmission towers, substations, and other galvanized products. Officers of the Stibloy Products Company, Inc., control of which has been acquired by the Koppers Products Company, are: president, J. N. Forker; vice-president, S. H. Bell; secretary, John D. Shaner; and treasurer, S. T. Brown.

New Multiple-Duct Concrete Conduits.—Two new designs of multiple-duct concrete conduits for underground high tension power cables and low tension telephone cables have been perfected by the McCracken Machinery Company, Sioux City, Iowa, which also produces equipment for their automatic manufacture. The concrete units are said to be non-fusible, with extremely smooth interiors, made in four-foot lengths, and the concrete, when adequately cured, develops a crushing strength of over 4,000 pounds per square inch, with less than 8 per cent absorption and waterproof resistance against 15 pounds hydrostatic pressure. For low tension lines the complete unit joint is grouted to prevent water filtration, but the ducts within the unit are not jointed. For high tension cables each duct is jointed independently. The extreme heat of short circuiting will not fuse the concrete, and the danger of a burnout damaging neighboring lines is said to be remote. The units are low in production cost as the manufacturing machine has a capacity of 30 duct-feet per minute of 6-way conduit, 20 duct-feet of 4-way conduit, and 10 duct-feet of 2-way conduit. Installation costs are reduced because narrower trenches will serve, joints are cemented before being placed in position, no extra excavation is needed to allow for plastering joints, and the units are laid at greater speed. The new multiple-duct type conduit has been adopted for important work in Uruguay by the International Telephone and Telegraph Company.

Trade Literature

Circuit Breakers.—Catalog 5, 16 pp. Describes Roller-Smith air circuit breakers, both open and enclosed; attachments and accessories of all kinds; relays and sectional steel, dead-front switchboards and cubicles. A complete line of the latter is offered and such switchboards may be made up of air circuit breakers, oil circuit breakers, indicating and recording instruments, dead-front knife switches or combinations of all four. Roller-Smith Co., 12 Park Pl., New York.

High Voltage Testing Equipment.—Bulletin GEA-1168A, 12 pp. Describes standard apparatus for making high potential tests on insulating oil, bushings, and solid dielectric material, and for conducting high voltage investigations. General Electric Co., Schenectady, N. Y.

Fuse Links.—Bulletin, 4 pp. Describes the "Bi-Metal" fuse link, a new development in fast blowing, low temperature fuse links for expulsion cutouts. Line Material Co., So. Milwaukee, Wis.

Floodlighting.—Bulletin 777, 28 pp. Describes various principles of floodlighting and includes numerous photographs of different types of installations. A simple method of planning floodlighting is outlined. Curtis Lighting, Inc., 1123 W. Jackson Blvd., Chicago, Ill.

Diverter Pole Generator.—Bulletin 55, 4 pp. Describes Diverter Pole generators for charging motive power batteries, which meet the standard specifications of the Electric Truck Manufacturers Association. The Electric Products Co., 1725 Clarkstone Rd., Cleveland, Ohio.

Testing Machines.—Bulletin 28, 36 pp. Describes hydraulic testing equipment for determining the physical properties of materials. Contains illustrations of typical installations, including the four million pound machine recently shipped to the University of California, claimed to be the largest universal testing machine in the world. Baldwin-Southwark Corporation, Philadelphia, Penna.

Meter Test Kits.—Bulletin. Describes types KS and KF meter test kits. Specifications—25 ampere capacity; light load current controlled by four toggle switches in fixed steps totaling $2^1/_2$ amperes; full load current between $2^1/_2$ and 25 amperes is controlled by rheostats, which provide a means for readily compensating for any variation in external impedance. A handy current indicator shows the current reading while the load is in use. The States Co., New Park Ave., Hartford, Conn.

"De-ion" Circuit Breakers.—Bulletin C1939, 8 pp. Contains a general description of a new line of "De-ion" circuit breakers. These breakers use a new method of arc extinction that enables elimination of all fuses in panel boards, distribution switchboards within the breakers' capacity and industrial applications where fused safety switches are now used. Bulletin C1937 describes construction and application details of the 225-ampere breaker. Westinghouse Elec. & Mfg. Co., East Pittsburgh, Penna.

Specifications for Butt-Treatment of Poles.—Bulletin, 4 pp. Contains specifications for the butt-treatment of Western red and Northern white cedar poles, incised process (Pentrex), as adopted by the Western Red Cedar Association and the Northern White Cedar Association. Bulletin, 2 pp., includes the specifications for the "B" process (no specific penetration guaranteed). Bulletin. 2 pp. Describes "AA" process (no specific penetration guaranteed). Naugle Pole & Tie Co., So. Wabash Ave., Chicago, Ill.